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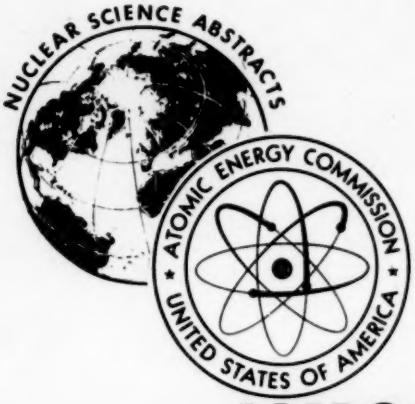


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Volume 18, Number 13, July 15, 1964

# NUCLEAR SCIENCE ABSTRACTS

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Volume 18, Number 13 July 15, 1964

# NUCLEAR SCIENCE ABSTRACTS

## BIOLOGY AND MEDICINE

### General

*Refer also to abstract 23139.*

**21742** (SGAE-BL-3/1964) IAEA-PANEL ON THE USE OF ISOTOPES AND RADIATION IN PLANT PATHOLOGY, VIENNA, SEPTEMBER 2-6, 1963. PART I. VIRUS NUCLEIC ACIDS. H. Altmann (Osterreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf, Austria). [1963]. 4p.

Tobacco mosaic virus was labeled with $^{14}C$ by means of photosynthesis in infected tobacco plants. The virus was isolated and used in studies of the role of RNA in the infective process. Results indicate that only virus RNA goes into the plant, only a small part of inoculated virus RNA is fixed in cell nuclei while the greater part remains in the cytoplasm, and virus infection affects DNA synthesis in infected cells. (C.H.)

**21743** (TID-7684(p.43-6)) ECONOMIC FEASIBILITY OF RADIATION-PASTEURIZED FRESH FRUITS AND VEGETABLES. John H. Droge (Department of Agriculture. Economic Research Service, Washington, D. C.).

Research was designed: to obtain preliminary estimates of the economic feasibility of marketing radiation-pasteurized fresh strawberries, peaches, citrus, grapes, and tomatoes from processors, wholesalers, retailers and institutional users; to compare expected losses in marketing channels due to spoilage and shrinkage of radiation-pasteurized fruit and similar untreated fresh fruit; to develop comparative estimates of costs of marketing fresh and pasteurized fruit; to evaluate the potential economic impacts of radiation pasteurization on market supplies and prices, methods of marketing, and the structure of markets for fruit. Results are outlined. (auth)

**21744** (TID-7684(p.69-71)) RESEARCH STUDY CONCERNING THE ORDERLY MARKETING OF IRRADIATED FISHERY PRODUCTS. A. L. Morel (Fish and Wildlife Service. Bureau of Commercial Fisheries, Washington, D. C.).

The Bureau of Commericial Fisheries entered into an agreement with the Atomic Energy Commission (AEC) to undertake a two-phase market research study concerning the future orderly marketing of irradiated fishery products. The objectives of the first phase of the program are to elaborate further on the contract study which the Bureau undertook for the AEC in 1960 regarding the marketing feasibility of radiation-processed fishery products, and also to attempt to determine the potential impact of radiation pasteurization on market supplies and structures. The second phase will consist of a highly qualitative study among consumers of fish and shellfish to determine what kind of educational program will be required to overcome the public fear of the concept of radiation in order to market irradiated fishery products most successfully. In essence, this second phase will involve a study of attitudes, information, misinformation, and psychological images as related to fish in general and irradiated fish in particular. The aim is to cover a sample of approximately 2,500 households from all geographic and city size strata on a national basis. The personal interview method of soliciting information will be employed by a private research firm under contract with the Bureau of Commercial Fisheries. (auth)

**21745** (TID-7684(p.91-7) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34° TO 50°F. C. F. Schmidt, W. P. Segner, J. K. Boltz, and J. H. Bock (Continental Can Co., Inc., Chicago).

Studies were conducted to define conditions under which Clostridium botulinum spores of Type E can germinate, grow, and produce toxin in the temperature range 38 to 50°F. Outgrowth of Type E spore inocula in a number of laboratory media at 46°F showed that outgrowth was highly dependent upon the formulation of the culture medium. Media showing the shortest outgrowth times at 46°F failed to support growth at 40°F. Considerable variation between the outgrowth time of Type E spore inocula was noted in different lots of blended haddock or sole at 42 and 40°F. Preliminary studies to determine the relation of salt concentration and incubation temperature to the growth of Type E spore inocula showed that while 1% and 2% salt had only a minor effect on the extension of outgrowth at 46°F, 3% salt caused a marked extension. Toxin assay procedures were tested in intact cells and cell suspensions microscopically and by applying ultrasonics. Neither method gave satisfactory results. (H.M.G.)

**21746** (TID-7684(p.168-75)) ECONOMIC ASPECTS AND PROSPECTS OF COMMERCIALIZATION OF RADIATION-PASTEURIZED FOODS. Joseph E. Machurek (Division of Isotopes Development, AEC).

Economics and potential commercialization of radiation processed fish, fruits, onions, and potatoes are discussed. Success of technology data related to fish, the Army's long term feeding studies on cod, and microbiological data, if borne out in large scale tests, will result in an attempt to induce industry to commercialize. Fruit-irradiation studies lead to the conclusion that chemical processing, where usable, is probably cheaper than irradiation. Secondly,

radiation where technologically appropriate, can maintain product quality in fruit in a manner equal to or better than chemical processing with no chemical residue. Technology in the fruit irradiation program is behind that of fish. Where chemical treatment is inadequate, such as for post-harvest storage of strawberries, irradiation does offer excellent results at an economically acceptable cost. Isolated commercial uses of radiopreservation, such as for potatoes, could begin within the next year of two. (H.M.G.)

**21747** (UCRL-11184) SEMIANNUAL REPORT—BIOLOGY AND MEDICINE, FALL 1963. John H. Lawrence, ed. (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 161p.

Eighteen papers were presented. Separate abstracts were prepared for 17; the remaining abstract appears in NSA as 18: 11794. (H.M.G.)

*For abstracts of individual papers see: 21748, 21766, 21767, 21768, 21769, 21770, 21771, 21772, 21827, 21927, 21961, 21962, 22093, 22344, 22345, 22410, and 22633.*

**21748** (UCRL-11184(p.20-36)) SOME PROPERTIES OF SERUM FROM RABBITS IMMUNIZED WITH HUMAN URINARY ERYTHROPOIETIN. John C. Schooley and Joseph F. Garcia (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

Sera obtained from rabbits after immunization with human urinary erythropoietin (ESF) can neutralize the biological activity of human urinary, sheep, rat, and rabbit plasma ESF. Such sera can depress erythropoiesis in normal mice. The neutralizing ability of such sera is found in the $\gamma$ globulins. The finding that absorptions of the immune sera with a wide variety of proteins did not alter the neutralizing ability suggests that considerable immunological specificity is involved in the neutralization reaction. This suggestion is further supported by the finding that immune sera against a variety of proteins do not effect the erythropoietic response elicited by the injection of exogenous erythropoietin. The injection or addition of antisera against proteins or protein hormones known to be of importance in normal erythropoiesis has little or no effect on the ability of exogenous ESF to stimulate erythropoiesis in polycythemic mice. One exception is anti-ovine thyrotropin, which significantly decreased the erythropoietic response seen in polycythemic mice after the injection of sheep ESF. The finding that mild acid hydrolysis destroyed the biological activity of human urinary ESF and altered antigenic determinants on the ESF molecule suggests that the groups necessary for biological activity may be specific antigenic determinants. These properties of the immune sera are consistent with concept, which was previously proposed, that the neutralization of the biological activity of ESF by anti-ESF is the result of an immunological reaction. The availability of such immune sera offers a potent tool for investigating many of the current problems on the role of ESF in the regulation of erythropoiesis. (auth)

**21749** (UCRL-11215) BIO-ORGANIC CHEMISTRY QUARTERLY REPORT, SEPTEMBER THROUGH NOVEMBER 1963. (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 20, 1964. Contract W-7405-eng-48. 29p.

Separate abstracts were prepared for 8 sections of this report. (C.H.)

*For abstracts of individual sections see: 21773, 21774, 21775, 21776, 21777, 21778, 21779, and 22119.*

**21750** (OTS-63-11453/2) JOURNAL FOR SCIENTIFIC AGRICULTURAL RESEARCH. Branko Pešič, ed. Translation of Arhiv za Poljoprivredne Nauke, 16: No. 52, (1963). 128p.

A separate abstract was prepared for one article in this journal. Other articles cover various studies on soils and agricultural problems. (C.H.)

*For abstract of individual paper see 21833.*

**21751** THYROID AND OVARY. P. Regidor, C. Gonzalez, and S. de la Pena (Instituto de Patologia Regional de Tenerife, Santa Cruz de Tenerife, Canary Islands). Acta Med. Tenerife, 17: 67(1962). (In Spanish)

The effect of an abdominal injection of 200 mC of $^{131}I$ on guinea pig ovarian and thyroid histology was studied, as well as the effect of a dose of 800 mC on rabbit ovaries, and the response, in these animals, of the uterus to female sex hormones. When female guinea pigs were sacrificed 20 days following intraperitoneal injection of 200 mC of $^{131}I$, histologic study showed considerable alteration of thyroid follicle morphology, the follicular lumen being nonexistent in many cases and in others greatly increased in diameter. Follicular epithelial cells appeared irregularly shaped, and in many follicles colloid was replaced by epithelium. In the ovaries there was evidence of follicular destruction, particularly in follicles at maturation. Ova appeared granular and irregular in shape. Some were displaced and absent from the ovarian cumulus. There were lesions in the zona glomerulosa, follicular liquid was frequently absent, and at other times clumps of irregularly staining material were present. Immature Graafian follicles were also adversely affected. In another experiment, female adult rabbits received an intraperitoneal injection of 800 mC of $^{131}I$ and later injection of estrogen for four days, followed by progesterone over a period of 8 days, and animals sacrificed seven days later. A histologic study of the uterus showed a failure of development of the pregravid endometrial mucosa and ovary showed similar lesions to those described above. The correlation between thyroid damage and ovarian atrophy was discussed. (BBB)

**21752** ESTIMATION OF PARASITIC BLOOD LOSS BY WHOLE-BODY COUNTING. Jay R. Georgi (Cornell Univ., Ithaca, N. Y.). Am. J. Vet. Res., 104: 246-50(Jan. 1964).

A method was devised which allows evaluation of blood loss due to intestinal parasites by use of radioiron retention as measured by whole-body counting. The method was tested on five sheep; two were free of intestinal helminths, but the others were infected. The rate of $^{59}Fe$ loss from the infected sheep was clearly greater than that from the noninfected sheep. A mathematical model derived to fit the experimental situation allowed calculation of the rate of stable iron loss. Sheep were given 0.5 to 1.0 $\mu$C of $^{59}Fe$ intravenously and counted within a few minutes. The advantages of the technique are described. (BBB)

**21753** ANNUAL REVIEW OF MICROBIOLOGY. VOLUME 17. Charles E. Clifton, Sidney Raffel, and Mortimer P. Storr, eds. Ann. Rev. Microbiol., 17: 1-628(1963). Palo Alto, Calif., Annual Reviews, Inc., 1963. 634p.

Reviews presented on recent advances in microbiology are: the nature of mycoparasitism by fungi, cell wall of yeasts, interspecific hybridization in the fungi, fine structure genetics and its relation to function, effects of environment on the composition of bacterial cells, bacterio-

phage reproduction, nitrogen fixation-role of ferredoxin in anaerobic metabolism, RNA synthesis and turnover in mammalian cells propagated in vitro, malignant transformation by Polyoma virus, coccidiosis, dwarf bunt on wheat, microbial toxins in plant disease, antibiotics in the control of plant disease, methods of immunologic injury to tissues, the interferrons-cellular inhibitors of viral infection, metabolism of microorganisms as related to their pathogenicity, new approaches to bacterial taxonomy, diatoms, structure of viral nucleoproteins, Toxoplasma and Toxoplasmosis, chemical composition and metabolism of protozoa, the pathogenic atypical myeobacteria, harmful and beneficial effects of plant viruses in insects, sensitivity to homografts of normal tissues and cells, and some recent advances in diagnostic medical bacteriology. (H.M.G.)

**21754** A NEW INSTRUMENT FOR OBTAINING INDICATOR DILUTION CURVES USING A RADIOACTIVE TRACER, $I^{125}$. J. T. Hobbs (St. Mary's Hospital, London) and A. M. Filipov. Brit. Heart J., 26: 75-83(Jan. 1964).

A smaller apparatus and a radioisotope giving lower patient radiation exposure were used to improve an instrument and technique previously described by the authors for measuring blood flow in the femoral artery by injecting a radioactive indicator into the femoral vein and sampling from the femoral artery. A new instrument was designed especially for obtaining indicator dilution curves by this technique. The use of $^{125}I$-labeled albumin introduces advantages: a lower net radiation dosage to the patient as well as to the operator; a much longer refrigerator shelf life; and need for little shielding to reduce background interference. An automatic injector is included in the instrument. The activity may be recorded logarithmically for direct extrapolation, and the permanent record is made on standard graph paper. The instrument is explosion proof and may be used in the operating room. It is compact and portable, weighing 31 kg. Safety override features prevent faulty techniques and the method is easily carried out by one person. The instrument was tested in the laboratory and details of the injector unit's performance are given. The overall instrument precision was found to be ±4.5%. Flow was determined by comparison of a suitable time-concentration curve with a standard. This standard could be prepared in water and give the same result as was obtained with blood. By contrast, use of dye as indicator requires the use of each patient's blood for the standard. The mathematical formulas used to obtain the various circulatory indices are given. A nomogram was constructed in the form of a simple plastic overlap that can be placed on the recorded curves and the various parameters immediately read off. The application of the method to the determination of cardiac output and femoral artery flow in the dog and in man is described, and typical curves are shown. The instrument may be used whenever indicator dilution curves are required. (BBB)

**21755** THE ETIOLOGY OF LEUKEMIAS, LYMPHOMAS, AND CANCERS. Edwin E. Osgood (Univ. of Oregon, Portland). Geriatrics, 19: 208-21(Mar. 1964).

A unifying concept of carcinogenesis and its relation to aging is presented. (BBB)

**21756** MEASUREMENT OF THE AMOUNT OF LIQUID FLOWING IN A UNIT TIME BY ISOTOPIC LABELING AND THE BIOLOGICAL APPLICATION OF THE METHOD. István Krasznai and Ferenc Solti (Clinic for Internal Medicine, Budapest). Magy. Fiz. Folyoirat, 11: 529-35(1963). (In Hungarian)

In order to determine the circulation rate of blood on the basis of the dilution of an isotopic indicator introduced into the arteries, the biological system was mocked up, using theoretical values reported by R. Andres and K. L. Zierler (J. Clin. Invest., 33: 489(1954)). The model was based on a countercurrent infusion and the $Na^{131}I$ isotopic indicator solution was introduced under a relatively high pressure into the low-pressure venous system. The results indicated that under an infusion pressure of $p_i$ = 0.15 kp/cm$^2$ and at a flow rate of F < 1000 ml/min, the amount of blood passing through the tubes can be determined with an error smaller than ±5%. At higher flow rates, the infusion pressure or the distance of the sampling location must be increased. In order to establish the biological applicability of the method, tests were carried out with dogs. To ensure the circulation of blood at the extremities of the animal, a Huffnagel type heart pump was used in the experiments. It was found that the modeling system can be transferred successfully to animal tests, with an experimental error of ±10%. (TTT)

**21757** PHYSIOLOGICAL PROBLEMS IN SPACE EXPLORATION. James D. Hardy, ed. Publication Number 561. American Lectures Series. A Monograph in the Bannerstone Division of American Lectures in Physiology, Springfield, Ill., Charles C. Thomas, 1964. 339p. $12.50.

Background information and the state of knowledge in several aspects of space psychophysiology are presented for the use of students and the interested general reader. Particular aspects discussed are: temperature problems in space travel; high energy radiations; food requirements in space; gaseous requirements in space; acceleration; weightlessness and sub-gravity problems; sensory and perceptual problems in space flight; isolation and disorientation; and physiologic rhythms. A separate abstract was prepared for one chapter. (H.M.G.)

*For abstract of an individual paper see: 21902.*

**21758** RADIOACTIVE METAL MOBILIZATION IN MEDICINE. Alexander Catsch. Publication Number 560, American Lecture Series. A Monograph in The Bannerstone Division of American Lectures in Living Chemistry. Translated from German by Bergene Kawin. Springfield, Ill., Charles C Thomas, 1964. 180p. $7.50.

Following a short review of the biological behavior of radiometals, pertinent concepts and terminology of coordination chemistry are outlined. A thorough analysis and discussion of theoretical foundations and of relevant experimental material (arranged according to individual radiometals) precedes the presentation of experiences with human beings. Special emphasis is placed on the toxic side effects of chelating agents. Guiding principles and recommendations for practical therapy are elaborated. Because this book involves numerous facets of experimental and clinical medicines as well as chemistry, it is necessarily addressed to readers in many disciplines: pharmacologists, toxicologists, clinical physicians, radiobiologists, biochemists, coordination-chemists, and physicians, and physicists concerned with health physics and radiation protection. (auth)

**21759** CARBON-14. A COMPREHENSIVE ANNUAL BIBLIOGRAPHY OF APPLICATIONS IN CHEMISTRY, BIOLOGY AND MEDICINE. VOLUME I. R. S. Scharffenberg and John K. Pollard, Jr. Los Angeles, California, Calibochem, 1962. 141p. $7.00.

References (1722) are given to journals and abstract journals for the period Jan. 1962 through Dec. 1962. Separate author and subject indexes are included. (P.C.H.)

**21760** A COMPARISON OF THE SENSITIVITY TO STORAGE AT 37°C IN TYRODE SOLUTION OF IMMUNOLOGICALLY COMPETENT CELLS AND OF MYELOID CELLS. J. L. Amiel and G. Mathe (Hôpital St. Louis, Paris). 6p. (CONF-500-2)

From Conference on Radiation Protection and Recovery, Oak Ridge, Tenn., Nov. 1963.

Two hours' storage at 37°C in Tyrode solution does not appreciably affect the number of lymph-node cells capable of bringing about myeloid restoration in an irradiated host; on the other hand, it affects 97.5% of the immunologically competent cells that are capable of evoking a graft-to-host reaction, a secondary syndrome in hematopoietic radiochimeras. (auth)

## Ecology

**21761** (RT/BIO(63)-8) RAPPORTO SULL'ATTIVITA SCIENTIFICA E TECNICA DEL LABORATORIO PER LO STUDIO DELLA CONTAMINAZIONE RADIOATTIVA DEL MARE — FIASCHERINO, LA SPEZIA (MAGGIO 1959–MAGGIO 1962). (Report of Scientific and Technical Activities of the Laboratory for the Study of Radioactive Contamination of the Sea — Fiascherino, La Spezia (May 1959–May 1962)). M. Bernhard, V. Boffi, A. Lucarell, L. Rampi, M. Melchiorri-Santolini, and A. Benedetti (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Feb. 1963. 178p.

Progress is reported on an investigation of the factors influencing the uptake, accumulation, and loss of radioactive substances by marine organisms of ecological importance and the passage of these substances in an ecological system. A survey on the distribution of the organisms and their nutrients present at a station in a chosen sampling zone in the Ligurian Sea was conducted. Total, total-soluble, and soluble reactive phosphate, inorganic silicate, oxygen, salinity, carbohydrates, and amino acids were determined after necessary methods had been set up. The distribution of phytoplankton, including nanoplankton, the sampling variability, the microdistribution with Van Dorn samples, and a continuous sampling apparatus were studied. The species that were dominant were cultured. Total and cultural counts of bacteria were carried out. On bacterial strains isolated from the zone, the metabolic characteristics were determined in order to arrive at a quantitative taxonomy. A semiquantitative study of the zooplankton was conducted and the fisheries products were analyzed on a few occasions. An ultrasound transmitter for pressure, temperature, and relative water velocity and a submarine photometer utilizing photoconducting cells were developed. Data are included on total $\beta$ radioactivity in plankton samples collected in 1959. (auth)

**21762** THE RADIOECOLOGY OF A BEACH. John Mauchline, Angela M. Taylor, and Eric B. Ritson (United Kingdom Atomic Energy Authority, Windscale, Cumberland, Eng.). Limnology Oceanog., 9: 187-94(Apr. 1964).

The accumulation of fission products, especially the insoluble radionuclides $^{106}$Ru, $^{144}$Ce, $^{95}$Zr, and $^{95}$Nb, by the fauna and flora on Windscale Beach is affected by the following factors: the particle size and chemical composition of the substratum; wind action on contaminated silt lifting it from near low-water mark and depositing it near high-water mark; the vertical position of organisms on the beach, and, therefore, their coverage time by contaminated seawater; movement of organisms on the beach which alters their coverage time; and freshwater seepage and rainfall, assuming that their radionuclide contents are less than that of the seawater, causing decontamination of the organisms by washing. The position of an organism in the food chain is not considered to be a primary factor determining the levels of radionuclides accumulated by it. (auth)

## Metabolism, Tissue Distribution, and Toxicology

**21763** (BNL-7940) DER MANGAN METABOLISMUS UND SEINE STÖRUNGEN. (Manganese Metabolism and Its Dearrangements). George C. Cotzias (Brookhaven National Lab., Upton, N. Y.). [Mar. 20, 1964]. Contract [AT(30-2)-Gen-16]. 7p. (CONF-476-1)

From Germany Society of Internal Medicine, Wiesbaden, Apr. 1964.

Manganese deficiency and chronic manganese poisoning were considered as homeostatic sicknesses. Injected radioactive manganese very rapidly left the blood vessels of animals and man. Equilibrium with manganese pools in the body was achieved very quickly. The chief accumulation region for $^{54}$Mn was various tissues that are rich in mitochondria. Incorporation of manganese in the hemoglobin, turn-over rate of manganese in tissues, effects of hormones on manganese metabolism, and functions of manganese in the body are discussed. (M.C.G.)

**21764** (SGAE-BL-4/1964) IAEA-PANEL ON THE USE OF ISOTOPES AND RADIATION IN PLANT PATHOLOGY, VIENNA, SEPTEMBER 2-6, 1963. PART II. ACTIVATION ANALYSIS IN VIRUS RESEARCH. H. Altmann (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf, Austria). [1963]. 5p.

Samples of nucleic acid from tobacco mosaic viruses were analyzed for trace elements by neutron activation analysis. The Cu content of virus RNA was found to be higher than the Cu content of the host nucleic acids. (C.H.)

**21765** (TID-7684(p.98-104)) STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS INVOLVED IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS. Alexander M. Dollar and John Liston (Washington. Univ., Seattle. Coll. of Fisheries).

The microflora of flounder and crab were studied before and after exposure to pasteurizing radiation (less than one megarad) with particular reference to organisms known to be important in spoilage and organisms of public health significance. In general, the numbers of bacteria present on fish and shellfish after irradiation were closely related to dose level. Neither coagulase positive Staphylococci nor Salmonellae were found in irradiated samples. Clostridium perfringens strains showed a highly variable sensitivity to radiation. Organisms isolated from crabmeat were tested for radioresistance, and no evidence was found of recovery and outgrowth of radiosensitivity of organisms during storage. Moreover, little evidence of a shift in the pattern of radiosensitivity toward more resistant forms was noted during storage. Experiments were also conducted on the protective effects of the suspending medium with Staphylococcus aureus and eleven species of Salmonella. Biochemical studies indicated that free water is important in the formation of free radicals and oxidative reactions, and it was clear that endogenous enzymes were not responsible for proteolysis in fresh tissue. (H.M.G.)

**21766** (UCRL-11184(p.6-19)) EFFECT OF ERYTHROPOIETIC STIMULATION ON MARROW DISTRIBUTION IN MAN, RABBIT AND RAT AS SHOWN WITH $Fe^{59}$ AND $Fe^{52}$.

Donald Van Dyke, Hal O. Anger, and Myron Pollycove (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

Distribution of marrow within the skeleton was determined in man, rabbits, and rats by in vivo labeling of the marrow compartment with radioiron and, depending on the resolution required, either assaying each bone separately for radioactivity or obtaining a gamma-ray image of the distribution of the marrow by whole-body scanner or with the positron scintillation camera. In man, extension of marrow into unusual sites was demonstrated only in cases with prolonged and severe stimulation, excessive blood loss, or hemolysis for a long period. A rabbit made severely anemic by administration of phenylhydrazine for seven days showed extension of marrow into the distal portion of the humeri and femora. In rats in which erythropoiesis was stimulated by erythropoietin administration, no significant increase in total marrow volume and no change in distribution of marrow within the skeleton were found. The positron scintillation camera provides an excellent method for qualitative evaluation of the marrow distribution. The camera has sufficient resolving power to give a good picture of the distribution of marrow with $^{52}Fe$ in a skeleton as small as that of the rat. The distribution apparent from the positron pictures has been confirmed by complete skeletal analysis of individual bones. (auth)

**21767** (UCRL-11184(p.37-50)) ELECTROPHORETIC BEHAVIOR OF $OsO_4$-FIXED AND $KMnO_4$-FIXED ERYTHROCYTES. Robert M. Glaeser and Howard C. Mel (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

Mobility-pH curves at ionic strength 0.145 and mobility-ionic strength curves at pH 7.3 are reported for $OsO_4$-fixed, $KMnO_4$-fixed, and unfixed rat red blood cells (RBC). $OsO_4$ fixation imparts great stability to the RBC, permitting extension of mobility measurements down to pH 0.9 and up to pH 12.3. The pH-mobility curves for $OsO_4$-fixed and for unfixed cells are identical over the entire range for which data can be obtained for unfixed RBC. Both types are isoelectric at pH 1.6. The $OsO_4$-fixed cells: reversibly acquire a positive charge below pH 1.6 and acquire an increased (negative) mobility above pH 11.0. These two new features are believed to represent intrinsic properties of the normal unfixed RBC. The entire extended mobility-pH curve appears consistent with the idea that outer-surface sialic acid (N-acylated neuraminic acid) is solely responsible for their charge (electrophoretic) characteristics. $KMnO_4$-fixed RBC show considerably altered pH-mobility (hence surface) characteristics, compared with $OsO_4$-fixed and unfixed RBC. This is ascribed to differences in chemical reactivity of $OsO_4$ and $KMnO_4$. Mobilities of both kinds of fixed cells are virtually identical at all ionic strengths at pH 7.3 but are lower than those of the unfixed cells at lower ionic strengths. (auth)

**21768** (UCRL-11184(p.51-4)) RAPID CONTINUOUS ELECTROPHORETIC CONCENTRATION OF DILUTE PROTEIN SOLUTIONS. Howard C. Mel, Hans F. Loken, and Joan Manning (California. Univ., Berkeley. Donner Lab.; California Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

A solution to the problem is described, using a specific example. The differences from the previously reported dye example are: use of a natural protein mixture, more concentrated sample solution (wt.%), larger sample flow rate, shorter steady-state residence time (in the flow-cell), higher concentration factor, and concentration effected without separation. (auth)

**21769** (UCRL-11184(p.55-86)) CONTINUOUS FREE-FLOW FRACTIONATION OF CELLULAR CONSTITUENTS IN RAT BONE MARROW. Howard C. Mel, Linda T. Mitchell, and Bo Thorell (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

A single-cell suspension of normal rat bone marrow is prepared mechanically. This suspension is continuously fractionated in free solution, under sedimentation rate conditions, using 1g only. With a sample flow of $2.2 \times 10^6$ cells/min and a 32-min steady-state residence time in the stable-flow free-boundary (STAFLO) flow-cell, the cells exit almost entirely into 7 of the 12 collection bottles. Maximum numbers of different cell types are observed, with good repeatability, in approximately descending order from top to bottom as follows: erythrocytes, erythroblasts, immatures, myelocytes, and mature granulocytes. Major changes are effected relative to the starting marrow composition, and very large relative enrichments are achieved for certain cell types. In addition to the rapid, mild, preparative aspect of this study, nominal sedimentation rates can be assigned for the different collection fractions, in the range of $3 \times 10^5$ to $4 \times 10^6$ Svedbergs, thus making a start on a simple physical classification of the cellular elements in this complex tissue. (auth)

**21770** (UCRL-11184(p.91-7)) INTERRELATIONSHIPS BETWEEN SERUM LIPIDS, SERUM LIPOPROTEINS AND LIPOPROTEIN COMPOSITION. Frank T. Lindgren, Norman K. Freeman, and Robert D. Wills (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

The interrelations between the low-density lipoproteins and the total serum level of the commonly measured lipids (total lipid, total cholesterol, phospholipid, and glycerides) were evaluated for 32 normal males (ages 35 to 49 yr). A most striking relation ($r = 0.99$) was observed between the level of the $S_f$ 20-$10^5$ (very low-density lipoproteins) and total serum glyceride. Chemical-composition studies indicated that the level of the $S_f$ 20-$10^5$ lipoproteins (or total serum glyceride) was positively correlated with the percentage composition of glyceride in two lipoprotein classes — the $S_f$ 0-20 and the $HDL_{2+3}$ lipoprotein class. The highest degree of correlation ($r = 0.90$) was observed for the high-density lipoproteins, suggesting their potential importance in the transport and metabolism of glycerides. (auth)

**21771** (UCRL-11184(p.113-20)) LIPID TRANSFER BETWEEN HUMAN HIGH-DENSITY AND $S_f$ 20-$10^5$ LIPOPROTEINS. Alex V. Nichols and Lester Smith (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

Transfer of $S_f$ 20-$10^5$ glyceride to human serum high-density lipoproteins (HDL) occurs during incubation of serum with $S_f$ 20-$10^5$ lipoproteins. Uptake of glyceride by HDL is associated with reciprocal reductions in HDL cholesterol ester content. An artificial lipid emulsion, Ediol, also transfers glyceride to HDL and displaces HDL cholesterol esters. The amount of glyceride transferred per amount Ediol glyceride added to incubation system is significantly less than observed for the $S_f$ 20-$10^5$ glyceride. The implications of such glyceride transfer and cholesterol ester dislocation to lipoprotein chemistry are discussed. (auth)

**21772** (UCRL-11184(p.150-6)) ON THE METABOLISM OF RADIOBROMIDE IN THE THYROID GLAND OF RATS. Gilles La Roche and R. Richard Brown (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

No evidence was found to support the hypothesis of bromine organification by the thyroid gland or serum of rats maintained on low-iodine diet up to 24 days. Radiobromide dosage was not found to significantly influence the concentrating ability of the thyroid gland or the amount of radiobromide in the sera as observed between groups of males. The level of radiobromide present in the thyroid gland or serum, 24 hr after administration, may be dependent on sex or on the chronic effects of low iodine intakes. (auth)

**21773** (UCRL-11215(p.1-5)) THE PURIFICATION OF CARBOXYDISMUTASE. P. W. Trown (California. Univ., Berkeley. Lawrence Radiation Lab.).

Carboxydismutase has been shown to be reversibly inhibited and also protected by sulfate ions, and to a lesser extent by phosphate at pH 7.6. The inhibition by sulfate is competitive with ribulose-1,5-diphosphate, but that by phosphate is complex and not subject to definition in competitive or non-competitive terms. Gel filtration on Sephadex G-200, with a high-ionic-strength eluent containing a high concentration of sulfate ions, as well as reduced glutathione and Versenol, led to a considerable purification of carboxydismutase. The resulting enzyme preparation was at least 95% pure and highly active. (auth)

**21774** (UCRL-11215(p.7-10)) A SEARCH FOR PHOTOINDUCED POLARIZABILITY CHANGES IN PHOTOSYNTHETIC AND MODEL SYSTEMS. Terry Trosper and Kenneth Sauer (California. Univ., Berkeley. Lawrence Radiation Lab.).

A search was made for photoinduced polarizability changes in photosynthetic and model systems. Light scattering was studied in suspensions of bacterial chromatophore aggregates from Rhodospirillum rubrum, PbS, and CdS suspensions in a lighttight box. The apparatus for measuring light-scattering changes included an analyzing light source, exciting light source, mechanical chopper, photomultiplier, and filter systems selected to separate analyzing and excited light. The observed changes were not considered significant, and it was concluded that the fraction of the excited particles in the suspension was too small to cause a noticeable effect. (C.H.)

**21775** (UCRL-11215(p.13-14)) SOME CHEMICAL ATTEMPTS TO SUPPORT AN OXIDATIVE PHOSPHORYLATION MECHANISM. Peter M. Scott (California. Univ., Berkeley. Lawrence Radiation Lab.).

Vilkas and Lederer have proposed a mechanism of oxidative phosphorylation. They consider the ring opening of a chromanyl phosphate to a hydroquinone phosphate that can then be oxidized to a quinone. Phosphate, according to their hypothesis, would then be reincorporated by addition to the isomeric quinone methine. The isomerization of the methyl quinone to the corresponding quinone methine was investigated by deuterium exchange at the methyl group and measurement of nuclear magnetic resonance spectra. Results do not support the proposed mechanism. (C.H.)

**21776** (UCRL-11215(p.18-19)) THE EFFECTS OF LIPOIC ACID ON THE REDUCTION OF CARBON DIOXIDE DURING PHOTOSYNTHESIS. J. A. Bassham, Frances Edmonston, and Martha Kirk (California. Univ., Berkeley. Lawrence Radiation Lab.).

An analysis was made of the transient changes in the levels of $^{14}C$-labeled compounds caused by the addition of lipoic acid to photosynthesizing chlorella in the presence of $^{14}CO_2$. Numerous samples taken before and after the addition of the inhibitor were analyzed by two-dimensional paper chromatography and autoradiography. The amount of $^{14}C$ in each compound was determined by means of an automatic spot counter. Results indicated that the effects of methyllipoic and lipoic acids cannot as yet be related to effects of other known inhibitors. (C.H.)

**21777** (UCRL-11215(p.15-17)) CHANGES IN CONCENTRATIONS OF $^{14}C$-LABELED COMPOUNDS IN PHOTOSYNTHESIZING CHLORELLA CAUSED BY ADDITION OF IODOACETIC ACID. Roger Hiller and J. A. Bassham (California. Univ., Berkeley. Lawrence Radiation Lab.).

Preliminary experiments on the inhibition of photosynthetic gaseous exchange by iodoacetic acid (IAA) showed that, at a concentration of $5 \times 10^{-4}$ M, a marked inhibition of both $CO_2$ uptake and $O_2$ output was observable between 2 and 4 min after addition of the inhibitor. Subsequently, the effect of IAA on the levels of $^{14}C$ in the carbon-reduction cycle was investigated with the steady-state apparatus. Algae cells (70 ml buffer containing 2% vol/vol packed Chlorella cells) were exposed to $^{14}C$ for 12 min, at which time the inhibitor was added. Killing, extraction, and analysis of results are discussed. (C.H.)

**21778** (UCRL-11215(p.20-2)) INHIBITOR STUDIES ON THE CARBON-REDUCTION CYCLE IN CHLORELLA. Edwin S. Gould, J. A. Bassham, and Martha Kirk (California. Univ., Berkeley. Lawrence Radiation Lab.).

Preliminary experiments showed that 2,4-dichlorophenyldimethylurea (DCMU) in concentrations greater than $10^{-5}$ M completely inhibited $CO_2$ uptake and oxygen evolution by illuminated Chlorella pyrenoidosa within one min after addition, but did not block respiration. With a DCMU concentration of $10^{-6}$ M, photosynthesis was about 65% inhibited within 6 min and about 80% inhibited in 18 min. At $10^{-7}$ M inhibitor concentration, there was no significant effect. The action of carbonyl cyanide m-chlorophenylhydrazone (CCCP) was less drastic. At $10^{-5}$ M, the hydrazone brought about complete inhibition of photosynthesis within about 1.6 min, but there was evidence of slight recovery (about 10%) after 10 min. No effect was observed at the $10^{-6}$ M level. Results are compared with other studies. Results do not support nor deny the existence of a reductive carboxylation reaction. They do demonstrate that with chemical inhibition reactions can be reproduced, in rapidity and magnitude, and transients in levels of carbon-cycle intermediate compounds can be demonstrated that were previously produced only by turning off the light. The information obtainable by this type of study is potentially much more meaningful than that obtained by long incubation with inhibitors (with consequent killing of the organism) prior to $^{14}CO_2$ addition. (C.H.)

**21779** (UCRL-11215(p.23-7)) STUDIES ON THE QUINONE COMPOSITION OF CHLORELLA PYRENOIDOSA. Hartmut K. Lichtenthaler (California. Univ., Berkeley. Lawrence Radiation Lab.).

Preliminary studies on isolation and identification of lipophilic quinones from Chlorella pyrenoidosa are described. Some remarks on their labeling are included. (C.H.)

**21780** (JPRS-24227) DATA ON ACCUMULATION COEFFICIENTS OF $P^{32}$, $S^{35}$, $Sr^{90}$, $Y^{91}$, $Cs^{137}$, AND $Ce^{144}$ IN MARINE ORGANISMS. G. G. Polikarpov. Translated

from Tr. Sevastopol'sk. Biol. St., Akad. Nauk SSSR, 14: 314-28(1961). 26p. (OTS-64-31088)

Data are presented on the accumulation coefficients of selected fission products and control radioisotopes in representative plants and animals of the Black Sea. The changes in accumulation coefficients of the fission products during detritus formation was also studied. Marine organisms studied included algae, sea grass, mollusks, and crustacea and the isotopes studied included $^{32}P$, $^{35}S$, $^{90}Sr$, $^{91}Y$, $^{137}Cs$, $^{143}Pr$, and $^{144}Ce$ in concentrations of 10 $\mu C/l$ of sea water. It was concluded that the biogeochemical conditions of the Black Sea do not meet the requirements for burial and neutralization of high-activity wastes from the atomic industry. (C.H.)

**21781** (JPRS-24301(Del.)(p.1-8)) FUNCTIONAL DISTURBANCES OF THE LIVER OF STRONTIUM-90 AFFECTED DOGS. A. A. Yusupov, A. I. Nevskaya, and N. I. Ovdiyenko. Translated from Byul. Eksperim. Biol. Med., No. 2, 29-33(1964).

Oral doses of $^{90}Sr$ of 1 $\mu C/kg$ of body weight had a marked effect on carbohydrate metabolism in the liver of dogs as reflected in the blood sugar level and results of liver function tests using $^{131}I$-labeled rose bengal. Maximum effects were observed during the first 14 to 30 days. Participation of the liver in $^{90}Sr$ excretion was demonstrated by activity of bile, which was maximum by the 90th day after $^{90}Sr$ administration. Morphological examination of the livers of all experimental dogs 180 days after $^{90}Sr$ administration showed vessel dilation and cell necrosis. (C.H.)

**21782** ABSORPTION AND TRANSLOCATION OF FOLIAR APPLIED $P^{32}$, $Ca^{45}$, $Fe^{59}$, AND $Cs^{137}$ IN VITIS VINIFERA L. Italo Eynard (Università, Turin). Accad. Ital. Vite Vino, Siena, Atti., 13(1961), 22p.(1962). (In Italian)

The foliar absorption and translocation of $^{32}P$, $^{45}Ca$, $^{59}Fe$, and $^{137}Cs$ in young seedlings of Vitis vinifera L. cv. Emperor was studied by applying one drop of active solution (1$\mu C$/ml) to the upper surface of a leaf blade on the median portion of the stem. All plants were grown in a growing room at an average daily temperature of +21°C, with a light intensity at plant level of 1500 foot candles, during 12 hr. Plants, harvested 24, 72, and 288 hr after treatment (each experiment was replicated five times) were segmented into plug (P), treated leaf (TL), stem and leaves above the treated leaf (SA), stem and leaves below the treated leaf (SB), roots (R); also a sample of vermiculite (V) was taken. All samples were dried and radioactivity determined with an end-window Geiger-Mueller tube and standard scaler circuit. Some dried plants were also mounted on heavy paper, covered with cellophane and placed in contact with Kodak Blue Brand x-ray films in order to portray the distribution of foliar absorbed elements by means of autoradiography. The behavior of $^{37}Cs$ and $^{32}P$ was quite similar and the percentage absorbed was 7.63, 11.76, and 14.39% for Cs, and 7.15, 11.85, and 13.78 for P after 24, 72, and 288 hr respectively. After one day the maximum amount of activity was found in treated leaves and just a little quantity in SB and R. After 3 days the activity in samples TL, SB and R was almost the same as that after 12 days. At third day the quantity of isotope in SA became to be sensible and increased until 12th day; at this time the activity was about the same (~1%) in SA and R. $^{59}Fe$ and $^{45}Ca$ were absorbed (11.81 and 14.79%, respectively) but not translocated, out of treated leaves, almost within the 12th day. (auth)

**21783** THE BEHAVIOR OF CERTAIN LANTHANONS IN RATS: STUDIES ON THE EXCRETION, SUBCELLULAR LIVER DISTRIBUTION, AND TOXICOLOGY AFTER INTRAVENOUS ADMINISTRATION. Goran Magnusson (Royal Veterinary Coll., Stockholm). Acta Pharmacol. Toxicol., 20: Suppl. 2, 95p.(1963).

A literature survey of the rare earth metals is given, and experimental studies were conducted on the representative lanthanons $^{144}Ce$, $^{147}Pm$, $^{160}Tb$, $^{166}Ho$, and $^{169}Yb$. In addition, $^{91}Y$, because of its similarity to the lanthanons, was investigated in Sprague-Dawley rats. During the first three hr after intravenous administration, blood concentration of these lanthanons dropped with varying rates. The amount of nuclides in the kidney was only a few per cent of the given dose during the first three hr; $^{91}Y$ and $^{160}Tb$ had the highest and $^{166}Ho$ and $^{169}Yb$ the lowest concentrations. Soon after intravenous administration, the investigated lanthanons reached high concentrations in the liver, up to 25 to 30% of the given dose of $^{91}Y$. Corresponding values for the other rare earth metals were 50% or more. The liver concentration diminished more rapidly for the heavy lanthanons including yttrium ($^{91}Y$, $^{160}Tb$, $^{166}Ho$, and $^{169}Yb$) than for the light lanthanons ($^{144}Ce$ and $^{147}Pm$). Excretion of the rare earth metals occurred via urine, bile, and gastrointestinal wall. During the first three hr, the excretion via urine was greatest with $^{91}Y$ and least with $^{166}Ho$ and $^{169}Yb$. Excretion via the wall of the gastrointestinal tract was appreciable, but gastric excretion was generally higher than the intestinal, at least during the first hour. Study of the subcellular distribution of the lanthanons in the liver showed that with $^{144}Ce$ and $^{169}Yb$ the nuclear fraction contained the lowest amount. The largest amount of both $^{144}Ce$ and $^{169}Yb$ occurred in the microsomes in female rats while male rats had the highest concentration of $^{144}Ce$ in supernatant and of $^{169}Yb$ in mitochondria and supernatant. An acute toxic effect on liver was obtained with the following doses, expressed as mg/kg body weight; Y 9, Ce 3, Tb 35, Ho 40, and Yb 60. Rare earth metals lowered the glucose level in the blood during the first 3 to 4 days after the intravenous administration. The lanthanons investigated induced acute liver damage, which was studied by determination of ornithinecarbamyltransferase (OCT) and morphologic investigations. During the first 3 to 4 days after intravenous administration, increased OCT values occurred and these were very high especially after injection of Ce into female rats. Cerium in female rats caused a diffuse liver damage seen as fatty degeneration, but in male rats it caused no fatty changes. All of the other lanthanons induced focal liver damage, intralobular necrosis, in female as well as male rats. These liver lesions might explain the decrease in blood glucose. Electron microscopic investigations showed changes in the mitochondria and endoplasmic reticulum; mitochondria were enlarged and their ground substance and cristae changed. Changes in endoplasmic reticulum were manifested as dilatation of the cisternae and loss of ribosomes. (BBB)

**21784** ON THE POSSIBILITY OF SUBSTITUTION OF STRONTIUM FOR CALCIUM IN MAIZE PLANTS. Pedro G. Pinto Da Silva (Estação Agronómica Nacional, Sacavém, Portugal). Agron. Lusitana, 24: 133-56(1962).

An attempt was made to substitute Sr for Ca in maize (Zea Mays L.) plants grown in nutrient cultures. In this way, Sr behavior could be compared with the Ca physiological role. A scheme of treatments was designed in which a gradual Ca deficiency was produced in one series and in another Sr replaced the withdrawn amount of Ca. Calcium and Sr were determined in a Beckman DU flame photometer

after their precipitation as oxalates followed by a digestion in nitric and perchloric acids. Symptoms of slight to extreme Ca deficiency in the presence or absence of Sr were observed in connection with support on the Ca importance as a cell membrane component. Strontium was not toxic but its capacity for substituting Ca has proved limited. The analytical results along with the confirmation of the limited Sr capacity for substituting Ca reveal a discrimination towards Ca whose intensity strengthened with decreasing Ca concentrations. This is discussed under the scope of root absorption and discrimination. (auth)

**21785** PARATHYROID HORMONE AND RELEASE OF CALCIUM 45 FROM BONE. Henry Jeffay and Harold R. Bayne (Univ. of Illinois, Chicago). Am. J. Physiol., 206: 415-18(Feb.1964).

An attempt was made to determine from which compartment of bone the Ca is released under the influence of parathyroid hormone. To do this, rats were raised on a homogeneous diet containing $^{45}Ca$. When the Ca of the bones and blood had the same specific activity as the diet, the rats were maintained on a normal nonradioactive diet until the specific activity of the different compartments were grossly different. Parathyroid hormone was then administered intraperitoneally, and the changes in specific activity of bones and serum were measured. The results show the increase in serum Ca following hormone treatment does not come entirely from the rapidly exchangeable compartment, but rather that parathyroid hormone also affects the slower exchanging fraction bone. (auth)

**21786** THE SKELETAL UPTAKE OF RADIOPHOSPHORUS ($P^{32}$). James N. Castle, A. B. Kenneth G. Scott, and William A. Reilly (Veterans Administration Hospital, San Francisco and Univ. of California, San Francisco). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 1128-31(May 1964).

Comparative measurements were made on a phantom skull and on patients under treatment for polycythemia vera using $^{32}P$. The uptake of $^{32}P$ by the skeleton was calculated. (auth)

**21787** $D_2O$ UPTAKE RATE IN TWO BRACKISH-WATER NEREID POLYCHAETES. Ralph I. Smith (Univ. of California, Berkeley). Biol. Bull., 126: 142-9(Feb. 1964).

The $D_2O$ influx was compared in two species of the worms, under conditions of no osmotic water influx and under conditions of hyperosmotic regulation in which there was an inward movement of water as a result of an osmotic gradient. Worms in 50% sea water are considered to be in osmotic equilibrium with the medium but those in 20% sea water and lower concentrations are known to be regulating, and thus maintaining an osmotic gradient which presumably causes a net inward water flux through the integument. Preliminary experiments indicated that $D_2O$ entrance in the absence of an osmotic gradient was very rapid (half-saturation times >5 min), so observations were confined to 5-min exposures to 5% $D_2O$, to reduce back-diffusion of $D_2O$ and recycling via the urine. Although Neresis limnicola showed a smaller salt loss and less net osmotic water uptake in a salt-free medium than did N. succinea, both species showed an equal $D_2O$ influx at a body weight of ~100 mg. As in the case of salt loss, N. limnicola follows the surface rule (uptake proportional to surface area) in its $D_2O$ uptake; N. succinea does not. No increased uptake of $D_2O$ was demonstrated in lower salinities in which there is presumed to be an osmotic inflow of water. This is consistent with the possibility that water permeability is less at low environmental salinities. The different osmoregulatory capabilities of these two species may be related to urine output (greater in N. limnicola), to a difference in integumental pore size (smaller in N. limnicola), or to some combination of these factors. The observed equality of $D_2O$ influx, independent of the apparent rate of osmotic water intake, suggests that N. limnicola has the more effective water-elimination system, which is consistent with its demonstrably better volume control. It is also evident that the $D_2O$ influx bears no relation to the tendency to outward passage of salts. (BBB)

**21788** BONE MARROW TRANSFUSION. Siegfried Witte (Universität, Erlangen, Ger.). Blut, 9: Suppl., 121p. (1963). (In German)

The literature is reviewed and 373 references cited. Both experimental and clinical data are considered. The technique of bone marrow aspiration, its preservation, and transplantation are described, as well as methods for labeling the donor cells and their detection in recipient animals. Autologous, homologous, and heterologous grafting of marrow in whole-body irradiated recipients and the effects of immunologic reactions, as early and late manifestations, are discussed. The use of bone marrow transplants in animals with leukemia and metastatic cancer, following treatment with cytostatic agents and the mode of action of such transplants are considered. The possible use of fetal and cadaver marrow for human grafts is discussed. Results of human studies of marrow grafting in the following conditions are outlined: drug-induced marrow aplasia, aplastic anemia, agranulocytosis, acute leukemia, lymphogranulomatosis, thrombocytopenic purpura, and agammaglobulinemia. At the present time, the late immune reaction of donor cells with those of the recipient, with the establishment of the chimeric state, precludes the successful use of marrow transplantation in the treatment of malignant human diseases. (BBB)

**21789** INFLUENCE OF GENOTYPE UPON RELATIONSHIP OF STRONTIUM 89 TO CALCIUM IN GRAIN OF BARLEY AND WHEAT. L. H. Smith, D. C. Rasmusson, and W. M. Myers (Univ. of Minnesota, St. Paul). Crop Sci., 3: 386-9(Sept.-Oct. 1963). (TID-19020)

In barley, statistically significant differences in $^{89}Sr$ and Ca contents and ratio of $^{89}Sr/Ca$ were observed among 20 varieties. These differences were relatively reproducible between two experiments conducted under different environmental conditions. Significant varietal differences with respect to $^{89}Sr$ and Ca contents, and $^{89}Sr/Ca$ ratio and the consistency of the differences under different environmental conditions suggest genetic control of these factors. A regression analysis indicated a general positive relation between $^{89}Sr$ and Ca accumulation in the grain. However, varietal exceptions to this general relation were also significant. Discrimination against $^{89}Sr$ accumulations by some varieties is suggested by varieties containing relatively high levels of Ca and low levels of $^{89}Sr$. In wheat, significant varietal differences were observed for $^{89}Sr$ and Ca contents and $^{89}Sr/Ca$ ratio. The data for $^{89}Sr$ accumulation were found to be reproducible over the two experiments, whereas the data for Ca were not. The relation of $^{89}Sr$ to Ca, as indicated by $^{89}Sr/Ca$ ratios, was relatively consistent over the two experiments. These data suggest a major influence of plant genotype upon $^{89}Sr$ accumulation and ratio of $^{89}Sr/Ca$ in the grain of some wheat varieties. The grain of the two species tested, barley and wheat, showed essentially the same mean accumulation of $^{89}Sr$ and Ca, indicating that little difference exists between these two species for $^{89}Sr$ and Ca accumulation. (auth)

**21790** THE PARTICULAR FEATURES FOR THE ACCUMULATION OF CESIUM-133 AND CESIUM-137 IN THE BRAIN OF MAN AND ANIMALS. I. V. Burovina, V. P. Nesterov, I. A. Skul'skii, and D. G. Fleishman. Dokl. Akad. Nauk SSSR, 154: 1229-30(Feb. 11, 1964). (In Russian)

The content of $^{137}Cs$ in the brain is lower than in other tissues, and may be due to the slow establishment of equilibrium of $^{137}Cs$ with the brain, or to the lower capacity of brain tissue for cesium compared to the capacity of muscle tissue for cesium. To study this problem further, the contents of stable $^{133}Cs$ and radioactive $^{137}Cs$ in the brain and muscle tissues were determined in man, deer, and cows. Stable $^{133}Cs$ was determined by isotopic dilution. The potassium contents in the brain and muscle tissues were also determined by flame photometry. The results showed that the stable cesium content in the brain tissue is a factor of three lower than in muscle tissue. The potassium content in the brain was about the same as the potassium content in the muscle tissues. The specific activity of $^{137}Cs$ in the muscle was greater than the specific activity of $^{137}Cs$ in the brain tissue. This behavior indicated that the exchange of cesium with brain tissue is slow, and that equilibrium was not established. The specific activity of $^{137}Cs$ was 1 to $2 \times 10^{-11}$ curies per 100 grams of brain tissue in man and the cow, and was $10^{-9}$ curies per 100 grams of brain tissue in the deer. (TTT)

**21791** THE MEASUREMENT OF THE RENAL CLEARANCE OF γ-EMITTING TRACERS BY THE USE OF EXTERNAL COUNTING. C. Bianchi and P. Toni (Università, Pisa, Italy). Experientia, 20: 148-9(1964).

Experiments made in order to test the possibility of measurement of the renal clearance of γ-emitting tracers by the use of external counting, the technique developed, and the results obtained are described. Increasing amounts of $^{131}I$ were introduced into the bladder by catheter, and the relation between the activity in the bladder and the counting rate over the bladder was studied at different degrees of vesical filling. A linear correlation was found up to a vesical volume of about 80 ml. 117 clearance rate measurements were carried out with the technique. The values obtained by external counting were compared with those calculated from the eliminated and plasmatic activities, measured in vitro. Satisfactory agreement was found between the two sets of measurements. (P.C.H.)

**21792** THE NATURAL CONCENTRATION OF $Ra^{226}$ IN BOVINE BONES AND TEETH. Elvira R. di Ferrante (Argonne National Lab., Ill.). Health Phys., 10: 259-64(Apr. 1964).

Although the natural $^{226}Ra$ content in twenty-five bovine mandibles ranged from 0.18 to 2.6 pCi/g ash, the average ratio of the concentration in bone to that in its permolar teeth was $1.03 \pm 0.20$. The $^{226}Ra$ contents of all permanent teeth from both sides of the lower jaw were determined in one animal and measurements were made on all teeth of half the lower jaw in eleven more animals. The radium content of the various teeth and of root and tip portions of a single tooth suggested variations in radium plasma levels due to discrimination of placental, mammary, and intestinal origin in addition to variations of available dietary intake. Measurements of the $^{226}Ra$ content of bone from one cow-fetus pair yielded a placental discrimination factor of 3; comparison with the literature implies the existence of specie differences. The ratio of $^{226}Ra$ in all the teeth to that in the bone averaged $0.92 \pm 0.11$, the concentration in bone falling between that of the highest and lowest tooth in ten of the twelve animals. Except for teeth partially formed in utero, variations from the mean were small (±15%) implying that judiciously chosen teeth provide suitable material for the evaluation of natural skeletal burdens of radium. (auth)

**21793** METABOLISM OF VITAMIN D. I. PREPARATION OF RADIOACTIVE VITAMIN D AND ITS INTESTINAL ABSORPTION IN THE RAT. David Schachter, James D. Finkelstein, and Szloma Kowarski (Columbia Univ., New York and Presbyterian Hospital, New York). J. Clin. Invest., 43: 787-96(May 1964).

Methods are described for the chemical preparation of $^{3}H$-vitamin $D_3$ and of uniformly labeled $^{14}C$-vitamin $D_2$ from $^{14}C$-ergosterol synthesized by yeast. The intestinal absorption of the labeled compounds was studied in vivo in the rat. Vitamin D is absorbed maximally in the jejunum and transferred chiefly into lymph. It was found mainly in the chylomicron fraction, as the free, biologically active sterol. Bile salt, specifically taurocholate as compared to taurodeoxycholate and taurochenodeoxycholate, is required for optimal absorption. Two steps can be distinguished in the transport across the intestine: uptake at the mucosal surface, relatively rapid, and transfer to lymph, relatively slow. Absorption is more rapid from mid-jejunal as compared to distal ileal segments primarily because the first, mucosal uptake step is more rapid and complete. (auth)

**21794** RELATIONSHIP BETWEEN $Hg^{203}$ EXCRETION RATE AND DIURETIC RESPONSE FOLLOWING $Hg^{203}$ MERCAPTOMERIN SODIUM ADMINISTRATION. Gerhard Levy, Benjamin Calesnick, and Arthur Wase (State Univ. of New York, Buffalo and Hahnemann Medical Coll., Philadelphia). J. Nucl. Med., 5: 302-3(Apr. 1964).

Data recently reported by Colesnick and Wase are examined. A comparison of the time course of diuresis with the time course of $^{203}Hg$ excretion rate leads to the additional conclusion that a definite time intensity relationship is indicated between diuresis and $^{203}Hg$ excretion due to $^{203}Hg$ mercaptomerin. (H.M.G.)

**21795** EFFECT OF RADIOTHYROIDECTOMY ON EEL INTERRENAL TISSUE. M. Olivereau (Institut Oceanographique, Paris). J. Physiol. (Paris), 55: 311-12(Mar.-Apr. 1963). (In French)

The effect of a large dose of radioiodine was examined to study the synergism between the thyroid and adrenal. A total dose of 240 to 450 μC of $^{131}I$ was given in one to five injections to eels, for the purpose of destroying thyroid tissue. Animals were sacrificed one to eight months later and their histology compared with controls. Thyroidectomy was complete in four out of six test animals and subtotal in the rest. In all cases adrenal tissue was more compact and appeared to be reduced in the majority; vascularization was diminished, interlobular sinuses narrowed, and interlobular spaces tended to disappear. Glycogen distribution was more heterogenous, accumulating at times at the periphery of cells which were reduced in size. Nuclear density was increased. Reduction in cell size was evident in four out of six eels receiving one to three injections and in all of those injected four or five times. Although the criteria used are of a morphologic nature, the changes probably indicate a condition of reduced adrenal activity because of their similarity to those produced by hypophysectomy. (BBB)

**21796** SOME PROBLEMS OF INTRALYMPHOVASCULAR INTRODUCTION OF RADIOACTIVE COLLOIDAL SOLUTIONS. N. V. Tarasov and D. A. Kazbekova. Med. Radiol., 9: No. 3, 12-17(Mar. 1964). (In Russian)

Subject to study was the influence of the volume, specific activity and quantity of particles of radioactive colloidal

solutions of gold ($^{198}$Au), chromium phosphate, and zirconyl phosphate ($^{32}$P) on the accumulation and character of isotope distribution in popliteal and medial iliac lymph nodes and internal organs of dogs during the administration of solutions into one of the superficial lymphatic vessels of the foot. It is shown that with alteration of the volume of colloidal solution introduced there occur changes in the accumulation and distribution of radioactive substances in these groups of lymph nodes. The specific activity and quantity of colloidal particles of solutions did not influence the accumulation and distribution of isotopes in lymph nodes and organs. (auth)

**21797** THE USE OF $Cr^{51}$ FOR LABELING ERYTHROCYTES. G. A. Malov and E. N. Ryumina (Inst. of Cardiac and Vessel Surgery, Academy of Sciences, USSR). Med. Radiol., 9: No. 3, 47-51(Mar. 1964). (In Russian)

Results are reported of investigations concerned with the elucidation of optimal conditions for labeling erythrocytes with $^{51}$Cr, supplied for medical purposes by laboratories. The volume of the circulating blood was determined and the average life of erythrocytes was studied. (auth)

**21798** A METHOD FOR CONTINUOUS MEASUREMENT OF GAS EXCHANGE AND EXPIRED RADIOACTIVITY IN ACUTELY ILL PATIENTS. J. M. Kinney, A. P. Morgan, F. J. Domingues, and K. J. Gildner (Harvard Medical School, Boston). Metab. Clin. Exptl., 13: 205-11(Mar. 1964).

A method is presented for continuous measurement of over-all gas exchange together with the pattern of expired radioactivity following the administration of tracer amounts of $^{14}$C-labeled foodstuffs. The knowledge, so gained, of a patient's gas exchange allows not only the calculation of energy expenditure by indirect calorimetry but also provides a reference for measurement of ventilatory and circulatory functions which influence gas exchange. The described equipment was designed to collect and record continuously a patient's expired $CO_2$, $O_2$, and $^{14}CO_2$. It is a closed system using a rigid transparent collection canopy which is practical for long tests with sick patients. Close control of temperature and pressure, with provision for internal calibration, permits ±2% accuracy. Concentration measurements are automatically integrated; readout is in chart and printed digital form. The equipment is installed in two adjacent rooms of a surgical metabolic unit. The patient's room is a conventional hospital room, with the collection canopy placed at the head of the bed. The canopy is made of transparent plastic with circular openings for the neck and connections for flexible air hoses; it contains a thermohygrometer and two loudspeakers connected to an intercommunication system. Gas analysis equipment is located in an adjoining room, from which the patient can be watched through a one-way window. Expired air and a proportion of incoming air leave the canopy and flow through a pipe to the analyzer. A flow from 35 to 40 l/min is most comfortable, and the usual uninterrupted sampling period is 3 hr, but patients have remained in the canopy for as long as eight hr. Sample flow is split between an ion chamber in parallel with infrared absorption $CO_2$ and $O_2$ detector heads, and pressure regulators are in a temperature-controlled oven, maintained at 42 ± 0.5°C. Output signals from each detector are presented on a separate strip chart recorder. Recorded volume percentages are continuously integrated by mechanical integrators, and integrator output is recorded on digital counters and printed out at preset intervals. (BBB)

**21799** TRANSFER OF RADIOACTIVITY FROM NUCLEAR TO CYTOPLASMIC RIBONUCLEIC ACID. Henry Harris (Oxford Univ.). Nature, 202: 249-50(Apr. 18, 1964).

To investigate the loss of radioactivity from nuclear RNA, $^{14}$C-labeled adenine was added to cultures of HeLa cells. Cells grown in the presence of labeled adenine for 18 hrs were washed and then transferred to a medium containing adenosine and guanosine. Nuclear RNA was separated from cytoplasmic RNA by treatment with polysaturated water, and specific activities of the two fractions were determined. Results clearly indicated a redistribution of radioactivity between RNA adenine and guanine. It is concluded that the main source for the net production of labeled guanine in the cells is the labeled adenine released by breakdown of nuclear RNA. Since most of the labeled adenine lost from the nuclear RNA appears in the cytoplasmic RNA not as adenine but as guanine, most of the labeled nuclear RNA presumably undergoes breakdown to acid-soluble end-products at least once before being transferred in a stable form to the cytoplasm. (H.M.G.)

**21800** FATE OF MOLYBDENUM-99 IN MAN. Betty Rosoff and Herta Spencer (Veterans Administration Hospital, Hines, Ill.). Nature, 202: 410-11(Apr. 25, 1964).

Molybdenum-99 blood levels and excretion were studied in man by means of a single tracer dose of 50-100 μC injected intravenously. Levels in plasma and whole blood were determined at 2, 4, 8, and 24 hrs, and urinary and fecal excretions were determined for periods of 5-13 days. Concentrations in whole blood were slightly higher than plasma, but there was a rapid decrease after injection dropping to 0.5 percent at 24 hrs. Excretion was highest the day of the injection and decreased thereafter with time, urinary excretion being higher than fecal excretion. (H.M.G.)

**21801** STUDIES ON THE PERMEABILITY OF SEA URCHIN PLASMA MEMBRANE BY NEUTRON ACTIVATION ANALYSIS. Reiji Hori (Toyama Univ., Japan). Radioisotopes (Tokyo), 12: 115-19(May 1963). (In Japanese)

The ashes of fertilized and unfertilized sea-urchin roe were irradiated by neutrons and the potassium and sodium contents were determined by neutron activation analysis. The potassium content of the roe was large while the potassium content of the sea water was small. The sodium content of the roe was small. The ratio of potassium and sodium was 11.2 for the unfertilized roe and 8.2 for the fertilized roe 10 min after fertilization. In the analysis of biological materials for potassium and sodium where little material can be obtained, neutron activation analysis is superior to flame photometric analysis. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21802** ASSAY OF STRONTIUM-90 IN HUMAN BONE IN THE UNITED KINGDOM. RESULTS FOR 1962, PART II. Medical Research Council Monitoring Report Series, No. 7. London, Her Majesty's Stationery Office, [1963]. 17p. 1s. 6d.

## Radiation Effects

**21803** (AECL-1890) GAMMA IRRADIATION IN CANADA. VOLUME III. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Mar. 1964. 113p.

Thirteen papers were presented. Separate abstracts were prepared for five, the remainder appear in NSA as: 15: 32190; 16: 21979, 32664; 17: 1277, 15668, 32329, 33996; and 18: 522. (H.M.G.)

*For abstracts of individual papers see: 21804, 21848, 21849, 21851, and 21852.*

**21804** (AEC-1890(p.42-53)) REPORT ON THE RESULTS OF THE CANADIAN PILOT SCALE POTATO IRRADIATION PROGRAM, 1961-1962 SEASON. (Atomic Energy of Canada Ltd., Ottawa).

A potato irradiation program using a Mobile Cobalt-60 Irradiator was carried out in four provinces of Eastern Canada during the 1961-62 season in cooperation with 26 members of the potato industry. A total of approximately 400 tons of potatoes was irradiated over a four-month period extending from October to February. Regular observations on both control and irradiated potatoes were conducted during storage by the Fruit and Vegetable Division of the Canada Department of Agriculture until final shipment to consumer markets or processing plants. The dose of 8,000 rads used in the program provided excellent control of sprouting in all storages regardless of variety, storage temperature, date of irradiation, method of storage, or length of storage. When good material suitable for long-term storage was irradiated and not mishandled during treatment, there was no effect on the rate of breakdown during storage. Irradiated potatoes were successfully processed into potato chips, instant mashed potato flakes, frozen french fries, and pre-peeled fresh boilers. Irradiated potatoes were sold to Canadian consumers in the form of table stock and processed products. No complaints of any kind were received or reported regarding the acceptability of the irradiated potatoes. There was no unfavorable public reaction to the first irradiated food offered for sale in Canada. The results of the potato irradiation program have created a favorable climate for the future of potato irradiation in Canada. The operation of full scale irradiation facilities is envisaged within the next two yr. (auth)

**21805** (AERE-R-4540) THE APPLICATION OF HIGH-ENERGY RADIATION TO THE STERILISATION OF SOME CLINICAL SOLUTIONS—THE INFLUENCE OF SEVERAL FACTORS UPON QUALITY. P. R. Hills (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Jan. 1964. 9p.

A study was made of the quality of radiosterilized perfusion fluids containing dextrose and fructose, under the influence of factors normally encountered in their preparation. Using data for the reduction in carbohydrate concentration and for acid formation, the significant effects were determined. Their quantitative influence was small. Carbohydrate radiolysis, which is effectively independent of concentration, varied with the other conditions employed between 0.1 and 2.2 g/l. The related figures for acid production were in the range 1.6 to 5.2 milliequivalents/l. (auth)

**21806** (BNL-805(p.46-58)) THE QUIESCENT CENTER IN MERISTEMS AND ITS BEHAVIOR AFTER IRRADIATION. F. A. L. Clowes (Oxford Univ.).

The quiescent center of root meristems is a region in which cell division occurs rarely. It lies at the pole of the stele and cortex surrounded by meristematic cells and arises from meristematic cells early in ontogeny. The average duration of the mitotic cycle in the quiescent center can be as much as 15 times that of continguous cells of the apex, and the degree of quiescence depends upon geometrical considerations and probably also on the phasing of syntheses. Accompanying the low rate of mitosis there are structural and chemical differences between the cells of the quiescent center and those of the rest of the meristem. After acute irradiation of roots there is a reversal in the roles of the regions of the apex. The rate of mitosis in the normally meristematic cells falls and that in the quiescent center rises. A group of cells in the quiescent center proliferates and produces a virtually new meristem which continues the growth of the root. The quiescent center suffers less radiation injury to the reproductive integrity of its cells probably because most of them are held in the $G_1$ phase of the mitotic cycle. This lower sensitivity combines with an initial advantage in the timing of mitosis to give the quiescent center its role in the reorganizing of the meristem. (auth)

**21807** (ORO-615) RADIATION PASTEURIZATION OF SHRIMP. Final Summary Report, January–December 1963. Arthur F. Novak (Louisiana State Univ., Baton Rouge). Jan. 14, 1964. Contract AT(40-1)-2951. 56p.

Low dose irradiation of headed, raw, unshelled shrimp with $^{60}Co$ resulted in an iced storage life extension of 10 days or longer than that of nonirradiated shrimp from the same catch. Chemical and bacteriological tests, and organoleptic attribute measurements were used to evaluate quality and acceptability. The process is commercially feasible, even when the shrimp are held iced for 3 or 4 days prior to irradiation. Cooked shrimp which were irradiated and iced stored retained their quality for a shorter period. Both raw and cooked shrimp stored at 38 to 40°F after irradiation did not have the keeping qualities comparable to those irradiated and stored in ice. Canned shrimp were irradiated, but the flavor and texture were altered unfavorably during commerical processing, and no advantages were anticipated by irradiation. Some flavor components, including fatty acids, carbonyl, and nitrogen compounds were isolated and then identified by gas chromatography. The metabolism of radiation resistant organisms was studied, and the effects of irradiation on some shrimp enzymes were determined. A dose of 0.15 Mrad gave maximum protection without any undesirable chemical or physical changes. The procedures employed for obtaining fresh shrimp, the method of handling and storing, and the time of holding prior to irradiation, are factors involved in ascertaining the keeping qualities after irradiation. (C.H.)

**21808** (TID-7684) RADIATION PASTEURIZATION OF FOODS. Summaries of Accomplishment. Presented at Third Annual Contractors Meeting, October 23-24, 1963. (Division of Isotopes Development, AEC and Division of Biology and Medicine, AEC). [nd]. 181p.

Twenty-nine papers were presented. Separate abstracts were prepared for 26; the remainder appear in NSA as 18:18110, 11628, and 17526. (H.M.G.)

*For abstracts of individual papers see: 21743, 21744, 21745, 21746, 21765, 21809, 21810, 21811, 21812, 21813, 21814, 21815, 21816, 21817, 21818, 21819, 21820, 21821, 21822, 21823, 21824, 21825, 21826, 22199, 22200, and 22201.*

**21809** (TID-7684(p.20-7)) STUDY OF RADIATION-PASTEURIZED FISHERY PRODUCTS. Louis J. Ronsivalli and Joseph W. Slavin (Fish and Wildlife Service. Technological Lab., Gloucester, Mass.).

Optimum radiation pasteurization dose levels were determined in air-packed pollock and ocean perch fillets to be 150,000 and 250,000 rads, respectively. Shelf life decreases with increase in preirradiation iced-storage time. Polyethylene and polypropylene films were found to be suitable for packaging, but not so effective as canning, perhaps due to faulty seals. Flavor tests showed that numbers and concentrations of volatile compounds were increased by radiation, storage, and cooking. High-vacuum techniques and chemical concentration methods with low

temperature programming of the retention column produced acceptable chromatograms. An additional index of quality used was total plate counts of bacterial populations. Bacterial reduction was 99% in haddock fillets given 250,000 rads. (H.M.G.)

**21810** (TID-7684(p.28-31)) RADIATION PASTEURIZATION OF SHRIMP. Arthur F. Novak (Louisiana State Univ., Baton Rouge).

During 1963, results on radiation pasteurization of shrimp showed: complete public acceptance in organoleptic tests in various cities, and plans are to include troop feeding at Ft. Lee, Virginia; radioresistant enzymes and microorganisms do not produce undesirable metabolic products; and only slight changes occurred during irradiation in some of the compounds responsible for the characteristic flavor and odor of shrimp. (auth)

**21811** (TID-7684(p.32-7)) RADIATION PASTEURIZATION OF PACIFIC CRAB AND FLOUNDER. David Miyauchi (Fish and Wildlife Service. Technological Lab., Seattle).

Optimum pre- and postirradiation conditions directed toward defining commercial process parameters are described for king crab (Paralithodes camtschatica), dungeness crab (Cancer magister), petrale sole (Eopsetta jordani), and Pacific halibut (Hippoglossus stenolepis). King crab meat was found to be best preserved when given 0.2 Mrad radiation, stored at 33°F, and vacuum-packed. Dungeness crab optimal conditions were defined as radiation doses between 0.1 and 0.4 Mrad, storage at 33°F, and packing in air or vacuum. The recommended radiation dose for preserving petrale sole was 0.2 and 0.3 Mrad, and it was determined that sole fillets must be vacuum-packed in order to minimize the development of rancid odor and flavor and also discoloration. Doses needed for Pacific halibut were between 0.2 and 0.4 Mrad. However, more specific definition of halibut dose awaits further experimentation. Although shelf-life was increased in the halibut by storage at 33°F instead of 42°F, the difference was not nearly so great as in the other species examined. Test of bacterial populations and volatile organic compound content were also conducted on each of the meats in the study. (H.M.G.)

**21812** (TID-7684(p.38)) EFFECTS OF IONIZING RADIATION ON LIPIDS OF FISH. Virginia F. Stout (Fish and Wildlife Service. Technological Lab., Seattle).

Radiation pasteurization is an effective method of increasing the shelf life of fishery products. After radiation, yellow, rancid spots sometimes appear. Naturally these reduce the value of the radiation preservation process. The chemical aspects of the causes of this oxidative rancidity are studied. Initially the effect of radiation on methyl docosahexaenoate, a model substrate for the highly unsaturated lipids present in fish, was studied. Under an inert atmosphere, no changes occurred in the lipid. Next, the effect of radiation on the autooxidizability of the substrate was investigated. Radiated methyl docosahexaenoate absorbed oxygen only slightly faster than the unirradiated control. Finally, the substrate was radiated in the presence of metal salts that are known catalysts of lipid autooxidation: cobaltous, manganous, and ferrous stearate. The iron salt caused darkening of the lipid during radiation. The other salts caused no obvious changes during radiation. Ferrous stearate catalyzed the uptake of oxygen slightly more in the radiated lipid than in the control. Cobaltous and manganous ions caused greater increases in the rate of oxygen absorption in the radiated samples. The exact amount of synergism of these metal ions and gamma rays is still unknown. (auth)

**21813** (TID-7684(p.39-42)) RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES. E. C. Maxie and N. F. Sommer (California. Univ., Davis).

Strawberries, the most promising fruit studied to date for gamma radiopreservation, are discussed in view of the parameters optimum for extension of the shelf-life by irradiation. Other fruits investigated and for which radiation doses are suggested include: cherries, nectarines, dewberries, raspberries, freestone peaches, Eureka lemons, Bartlett pears, and tomatoes. Radiosensitivity of the more important fruit decay fungi was investigated by means of the establishment of dose-response curves and by endpoint analyses. Of greatest promise appears to be the use of radiation as a fungistat to delay the development of lesions in the most highly perishable fruits. (H.M.G.)

**21814** (TID-7684(p.47-52)) IRRADIATION PASTEURIZATION OF FOODS. Lloyd L. Kempe (Michigan. Univ., Ann Arbor), H. L. Seagran, J. A. Emerson, N. Kazanas, R. A. Greig (Fish and Wildlife Service. Bureau of Commercial Fisheries, Ann Arbor, Mich.), P. Markakis, R. C. Nicholas, and B. S. Schweigert (Michigan State Univ., East Lansing).

Gamma irradiation studies were designed to evaluate the amenability of inland fruits and vegetables and freshwater fish to preservation by irradiation pasteurization. Cobalt-60 sources were used to establish guidelines of dosage, estimate extension of shelf-life, and survey potential problem areas in the radiopreservation of yellow perch fillets and dressed smoked chub. Total volatile base or total volatile acid values were found to be useful objective chemical methods for spoilage detection in perch. Yellow perch fillets cut from Lake Erie fish were irradiated at 0, 0.3, and 0.6 Mr and stored at 33°F. Products were evaluated organoleptically, chemically, and microbiologically. Results indicated some initial lowering of acceptance due to irradiation. Preliminary organoleptic screening tests on smoked chub indicated no large differences in acceptability resulting from irradiation at 0, 0.1, 0.4, or 0.8 Mr. Strawberries were packed in polyethylene bags and exposed to gamma irradiation from $^{60}Co$ and electron beams accelerated in an electron transformer. Color, texture, and microbiological measurements were made. (H.M.G.)

**21815** (TID-7684(p.53-4)) EFFECTS OF LOW-LEVEL IRRADIATION UPON THE PRESERVATION OF FOOD PRODUCTS. R. A. Dennison (Florida. Agricultural Experiment Station, Gainesville).

Organoleptic evaluations were made on gamma-irradiated citrus fruits and tomatoes. The most satisfactory method of presentation to a taste panel consisted of blending the fruits, deaerating the juice, and serving at a temperature of 10°C. Flavor differences were noted in fruits receiving 200 kilorads of irradiation. Determinations of color, pH, and titratable acidity did not yield any consistent differences between control fruits and those receiving 50, 100, or 200 kilorads. (H.M.G.)

**21816** (TID-7684(p.58-63)) GAMMA RADIATION TREATMENTS TO EXTEND THE MARKET LIFE OF FRUITS AND VEGETABLES. H. M. Couey, W. J. Bramlage, and W. J. Lipton (Department of Agriculture, Agricultural Marketing Service, Fresno, Calif.).

Under the conditions of these tests, gamma radiation

proved beneficial to fresh strawberries, peaches, nectarines, and figs. Several exploratory tests have also indicated that modification of the atmosphere surrounding fruits during irradiation can in some cases reduce injury to the fruits. Therefore, it may be possible to avert some of the problems that limit the use of radiation on other commodities. Nevertheless, the data illustrate an important point: feasible doses of radiation can control decay for only a limited time. Even at low temperatures, decay will develop on irradiated fruits during extended storage periods. The potential role of radiation in fruit marketing appears to be more that of reducing decay during the normal marketing period than that of greatly extending the storage life. (auth)

**21817** (TID-7684(p.64-8)) THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS. R. O. Sinnhuber, J. S. Lee, and A. W. Anderson (Oregon State Univ., Corvallis).

Experiments were designed to: study the shift in the natural microbial flora (including yeasts and molds) due to the variation in irradiation resistance and determine the spoilage by these microorganisms and their pathogenicity; determine whether a significant number of those microorganisms that survive are mutants, and their role if any in spoilage; and investigate the complementary effects of approved food additives such as nitrides, nitrates, sodium chloride, and possibly other radiolethal agents. The maximum allowable radiation dose was determined by taste panel methods; kinds, types, and pathogenicity of the surviving microorganisms by conventional methods; and microbial flora and spoilage pattern by chemical and microbiological techniques. Microbial loads were determined in fresh, untreated samples of Dover sole. Radiation at a level of 0.1 megarad was found to eliminate approximately 90 to 95% of the initial population in dover sole and 0.5 megarad reduced the microbial count by over 99%. The normal flora was composed of from 10 to 40% of Gram negative rods. Radiation exhibited a degree of selectivity on this group of organisms and they were eliminated progressively as the dose increased. After radiation exposure, the predominant position was taken by Gram positive cocci. This group remained predominant throughout storage when radiation doses of 0.25 and 0.50 megarad were employed. Sodium benzoate treatment did not change the microbial flora while sodium nitrite reduced the Gram negative rods in a manner similar to radiation. Attempts to isolate anaerobic spore formers from Dover sole irradiated and stored at low temperatures were unsuccessful. Flavor changes were noted at 0.5 megarads. (H.M.G.)

**21818** (TID-7684(p.73-8)) PROGRESS REPORT OF EXTRACTIVE STUDIES OF PACKAGING MATERIALS TO BE USED WITH IRRADIATED FOODS. O. D. Easterday, E. A. Garlock, and O. E. Paynter (Hazelton Labs., Falls Church, Va.).

A study was made to determine to what extent, if any, radiation alters the nature or amount of extractables from food-packaging materials. Food-simulating solvents added to extraction cells containing samples of the material in question were exposed to 1.0 megarad doses of $^{60}$Co gamma rays. After storage for seven days, infrared spectra were obtained for the chloroform-soluble extractables in the residues. It was concluded that 1.0 megarad of gamma radiation does not significantly change the extractables in food packaging materials. (H.M.G.)

**21819** (TID-7684(p.79-80)) PREPARATION OF FOOD ADDITIVE PETITIONS. O. E. Paynter (Hazelton Labs., Falls Church, Va.).

Submission of Food Additive Petition 1233 requesting issuance of a food additive regulation permitting the safe use of gamma radiation as a means of controlling citrus fruit spoilage, and the preparation of a second petition requesting similar action on several kinds of fresh produce are announced. (H.M.G.)

**21820** (TID-7684(p.83-4)) THE WHOLESOMENESS EVALUATION OF IRRADIATION-SUBSTERILIZED FOOD PRODUCTS. Elwood F. Reber (Illinois. Univ., Urbana. Coll. of Veterinary Medicine).

A contract to determine the protein value and the wholesomeness of irradiation-pasteurized sea foods was initiated June 23, 1963. Marine products were to be irradiated for subsequent protein evaluation. Soft-shell clams were irradiated at 400,000 and 800,000 rad; haddock at 200,000 and 400,000; crab at 200,000 and 400,000; and flounder at 300,000 and 600,000 rad. The irradiated marine products were to be stored at 33 to 35°F for 30 days and then frozen. The frozen materials were prepared for protein evaluation studies. (auth)

**21821** (TID-7684(p.85-6)) WHOLESOMENESS OF IRRADIATED STRAWBERRIES. Margaret Ives (Industrial Bio-Test Labs., Inc., Northbrook, Ill.).

Wholesomeness studies on irradiated strawberries are outlined. The toxicity study using strawberries irradiated with 150,000- and 300,000-rad doses will be conducted on white Leghorn chickens, pure-bred beagle dogs, and Sprague-Dawley albino rats. (H.M.G.)

**21822** (TID-7684(p.87-90)) A STUDY OF THE EFFECT OF IONIZING RADIATION ON RESISTANCE, GERMINATION AND TOXIN SYNTHESIS OF CLOSTRIDIUM BOTULINUM SPORES, TYPES A, B, AND E. John T. Graikoski and Lloyd L. Kempe (Michigan. Univ., Ann Arbor).

Radioresistance, germination, growth, and toxin production were studied in Clostridium botulinum Type E spores. Growth experiments were conducted in tubes of radiosterilized haddock homogenates and nutrient broth incubated at various temperatures. In the broth cultures growth was detected earlier than in the hadock homogenates; but the patterns of growth in broth at various temperatures were similar, whereas growth pattern variations were observed in the haddock homogenate tubes. Toxin production was found to be variable in several strains in various seafood homogenates. The radioresistance of seven strains of Type E spores were compared in phosphate buffer. The results showed that all strains are of similar resistance under these conditions, and that they are less resistant than Types A and B spores. Irradiation in oyster juice or haddock homogenates increased radioresistance. Heat resistance and dormancy were studied in stock spore suspensions exposed in phosphate buffer for various periods of time at temperatures of 60, 65, 70, 75, 85, and 90°C. In three of the strains a reversion of toxic to nontoxic phases was observed. Preliminary studies were made concerning the effects of carbohydrates and pH of medium on toxin production. Radioresistance of C. perfringens spores was determined in phosphate buffer and broth, and found to be similar to C. botulinum Types A and B resistance. (H.M.G.)

**21823** (TID-7684(p.105-7)) RADIATION BIOCHEMISTRY, PHYSIOLOGY, AND MICROBIOLOGY OF FRUIT. R. J. Romani and N. F. Sommer (California. Univ., Davis).

Effects of ionizing radiation that may explain the metabolic stress and textural changes occurring in irradiated fruit were investigated with emphasis on those parameters that affect the sensitivity and recovery of the fruit pathogens. Of the physiological effects of radiation, that which is most detrimental to the development of radiation technology is the marked loss of texture. The effect may be mediated by either direct radiochemical events or altered enzymatic activity, or both. Pectin methylesterase activity was increased by ionizing radiation, whereas polygalacturonase activity was reduced. Other studies include a survey of volatiles emanating from irradiated pears; quantitative measurements of anthocyanin loss in cherries, strawberries, and peaches; and amino acid content of irradiated cherries and pears. Density-gradient centrifugation techniques were used to discern the degree of qualitative change in intracellular particles in fruit tissues. Results of density-gradient studies indicated a shift in mitochondrial populations to units of less density as a consequence of radiation stress. Enzymatic assays, including transaminase, succinoxidase, cytochrome oxidase, and fumerase were performed on various particulate fractions. Techniques were developed and evaluated in vivo and in vitro for study of the quantitative dose-response of filamentous fungi to gamma irradiation. (H.M.G.)

**21824** (TID-7684(p.108-9)) BIOCHEMISTRY AND PHYSIOLOGY OF IRRADIATED FRUITS AND VEGETABLES. L. M. Massey, Jr. (New York. State Agricultural Experiment Station, Geneva).

Radiation research was conducted to elucidate changes that occur in plants and plant constituents as a result of gamma irradiation and to develop means of alleviating the undesirable effects in favor of the desirable. Respiratory activity response of plant tissue to gamma radiation indicated a dose-rate dependent acceleration in the kilorad-per-hour range followed by a return to near-normal rates following the cessation of treatment. It was also noted that the incidence of some storage disorders of physiological origin may be modified by relatively low doses of gamma radiation, and that the production of some of the volatile constituents from fruits are decreased by irradiation. The influence of water relations in irradiated plant tissues to radioinduced softening was studied, and evidence suggested that changes in the differential permeability of cell membranes may be involved. Plans for future work are discussed. (H.M.G.)

**21825** (TID-7684(p.110-12)) RADIATION OF HEME PROTEINS. W. D. Brown (California. Univ., Berkeley. Inst. of Marine Resources).

Studies were made of the effect of $^{60}Co$ irradiation on solutions of highly purified sperm whale and yellowfish tuna myoglobins. Solutions were contained in glass vials, in a nitrogen atmosphere, and were irradiated at levels of 0 to 500 krad. Fractionated, protein-free, myoglobin preparations were used to investigate changes in solubility, changes in absorption spectra, ultracentrifugal effects, pH changes, heme-globin linkage, loss of -SH groups, and electrophoretic effects. (H.M.G.)

**21826** (TID-7684(p.155-67)) WHOLESOMENESS, NUTRITIONAL ADEQUACY, AND MICROBIOLOGY OF RADIATION-PASTEURIZED FOODS. Leo A. Whitehair (Division of Biology and Medicine, AEC).

The Division of Biology and Medicine, AEC, supports studies in the areas of wholesomeness, microbiology, biochemistry and physiology of low-dose irradiated foods. Two-year animal feeding studies on soft-shell clams and protein availability studies on haddock, flounder, and crab were recently initiated (University of Illinois). The protein availability data will essentially complete the required wholesomeness data for haddock, crab and flounder. Long-term animal feeding studies on strawberries will also be conducted (Industrial Bio-Test Laboratories, Inc.). Foods for these wholesomeness studies are being irradiated at the Natick facility. Two studies on growth and toxin production of various strains of Cl. botulinum, Type E in various substrates and media, as well as marine homogenates are in progress (University of Michigan and Continental Can Co., Inc.). The ultimate objective of both of these studies is to evaluate any possible public health hazards involved in the prolongation of refrigerated storage life of food by application of low doses of radiation. Microbiological and biochemical studies on irradiated fish are underway at the University of Washington. Efforts were concentrated on the bacteriological safety of radiation-pasteurized seafoods. Potentially pathogenic organisms are being studied to determine their sensitivity to radiation, outgrowth after irradiation, and physiological changes after irradiation. Biochemical studies are designed to identify products and mechanisms involved in the tissue changes and relate them to radiation dose levels. Basic studies on the radiation biochemistry of fruits are being conducted at the University of California (Davis). The effects of ionizing radiation on cellular and intracellular structure and metabolism of fruit tissues are being explored. Investigations on the physiology and microbiology of fruits are also being conducted. The biochemical and physiological changes in fresh fruits and vegetable tissue (associated with extension of shelf-life by means of radiation) are being studied at Cornell University (Geneva Agricultural Experiment Station). Softening changes which occur in plant tissue during and after exposure to radiation will be investigated. Fundamental flavor and odor studies on volatiles from irradiated fish are being conducted at the Gloucester Laboratory. Attempts will be made to correlate gas chromatogram patterns with detailed results of organoleptic testing on the same fish products. A study on the biochemical alterations in the protein moiety of hemoproteins (fish myoglobin) as a result of radiation is being made at the University of California (Berkeley). The findings in each of these studies will be welded and previous results obtained in the Army's program and with results of studies currently supported by the Division of Isotopes Development. (auth)

**21827** (UCRL-11184(p.128-35)) STUDIES ON THE MAMMALIAN RADIATION SYNDROME WITH HIGH-ENERGY PARTICULATE RADIATION. II. SOME FACTORS AFFECTING RBE OF 730-Mev PROTONS. Charles A. Sondhaus, James K. Ashikawa, Cornelius A. Tobias, Vally Paschkes, and David Love (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab).

A series of seven experiments was performed with 730-Mev protons, 100-kvp and 250-kvp x radiation, and the relative lethality and time course of radiation injury was studied in more than 2,000 Swiss Webster white male mice. The 6-, 12-, and 30-day mortality values for Swiss Webster male mice exposed to 100- and 250-kvp x rays and 730-Mev protons are based on a preliminary analysis of the mortality data. In order to compare accurately the different experimental parameters, each $LD_{50}$ value was calculated from the regression of mortality by graphical probit analysis. For 730-Mev protons, the total-body 30-day $LD_{50}$ was

found to be 650 rads, air dose. The 12-day $LD_{50}$ values, however, were 680 rads at 1,000 rad/min and 700 rads at 100 rad/min, and the 6-day $LD_{50}$ was 730 rads and 810 rads, respectively, at the two dose rates. For 250-kvp x radiation filtered with 0.5 mm Cu + 1.0 mm Al, the 30-day total-body $LD_{50}$ was 520 rads, air dose, for both 100 rad/min and 20 rad/min dose rates. The 12-day $LD_{50}$ was 610 and 630 rads, respectively. The 6-day $LD_{50}$ was approximately 1,000 rads at 100 rad/min; the 6-day $LD_{50}$ at 20 rad/min is being investigated. For 100-kvp x radiation filtered with 1.0 mm Al, the 30-day total-body $LD_{50}$ was 750 rads, midline air dose, for both 100 rad/min and 20 rad/min dose rates. The 12-day $LD_{50}$ was 850 and 900 rads, respectively, while the 6-day $LD_{50}$ levels were not reached at the total doses given so far but can be estimated to be approximately 1,100 rads at 100 rad/min and greater than 1,300 rads at 20 rad/min. On the basis of these data, tentative estimates of proton RBE may be made for gut death as well as for 30-day $LD_{50}$. It is apparent from the results of these experiments that RBE values can differ between radiations of similar LET even under uniform exposure geometry, when differences in dose-rate dependence and injury mode are present. It is therefore clearly necessary to specify the effect to which a proton exposure RBE applies. In addition, a dose-rate factor must be introduced in calculating RBE for exposures to low-LET radiations. The exposure to high-energy protons in future space operations may be an important practical case of low-LET particulate radiation exposure. (auth)

**21828** (USNRDL-TR-713) CARCINOGENESIS BY FAST NEUTRONS RELATIVE TO X RAYS IN MICE: EFFECT OF UNINEPHRECTOMY AND OF $CCl_4$. L. J. Cole and P. C. Nowell (Naval Radiological Defense Lab., San Francisco). Jan. 15, 1964. 25p. (AD-433886)

Young adult $LAF_1$ mice received a single sublethal exposure to fission spectrum neutrons, and were treated as follows: Group I, 195 to 199 rad followed by a single subcutaneous injection of $CCl_4$ one month later; Group II, $CCl_4$ injected one day prior to neutron irradiation (280 to 329 rad); Group III, $CCl_4$ only, no irradiation; Group IV, unilateral nephrectomy carried out one day before neutron irradiation (320 to 328 rad); Group V, neutron irradiation only (200 to 320 rad). In the Group I mice sacrificed 12 to 16 months post irradiation, 75% exhibited hepatomas, while 92% of the mice in Group II showed hepatomas. By contrast, liver tumors appeared in 14% of mice receiving neutron irradiation only (Group V), and in only 2.4% of mice exposed to a single dose (500 rad of 200 kvp x ray). The incidence of kidney adenomas plus tubular and Bowman's capsule proliferations approached 100% in the uninephrectomized irradiated mice (Group IV), whereas such lesions were infrequent in control mice. The induction of these neoplasms is discussed in terms of carcinogenic initiation by neutron radiation and promotion by the specific proliferative stimuli employed. The data suggest a potency factor of approximately 2 for fission neutrons relative to 250 kvp x rays with respect to initiation of kidney neoplasms in mice. With respect to the occurrence of lymphomas, the neutron-irradiated mice showed a reduced incidence (11%) as compared with that of the x-irradiated animals (29%). (auth)

**21829** (FTD-TT-64-33) SOME RESULTS AND PROBLEMS IN THE FIELD OF SPACE RADIOBIOLOGY. P. P. Saksonov, V. V. Antunov, and N. N. Dobrov. Translated from Vestn. Akad. Med. Nauk SSSR, No. 8, 13-20(1963). 13p.

Data are summarized from biological studies conducted during four space flights at altitudes of 180 to 320 km for time intervals ranging from 1.5 to 95 hr. Results indicate that, in the absence of solar flares and with sufficient protection, brief, manned orbital flights hold no danger from radiation when conducted below the radiation belts. Radiation doses as high as 0.5 rem were recorded on dosimeters during one flight. It is pointed out that the cosmic radiation doses encountered had no adverse effects on the cosmonauts. (C.H.)

**21830** (JPRS-24301(Del.)) STUDIES OF PHYSIOLOGICAL REACTIONS TO IRRADIATION AND OTHER FACTORS, AND THE USE OF BIOTELEMETRY. Translated from Byul. Eksperim. Biol. Med., No. 2, 29-40(1964). 22p. (OTS-64-31131(Del.))

Separate abstracts were prepared on the 3 articles in this report. (C.H.)

*For abstracts of individual papers see: 21781, 21831, and 21832.*

**21831** (JPRS-24301(Del.)(p.9-16)) DYNAMICS OF WHITE BLOOD RESPONSE TO IRRADIATION. I. K. Petrovich and Yu. I. Moskalev. Translated from Byul. Eksperim. Biol. Med., No. 2, 33-7(1964).

The early response of leukocytes to doses of x radiation ranging from 50 to 12,000 rads was investigated in rats at time intervals of 5 to 1440 min. after exposure. Results confirmed the existence of an essential difference in the response of lymphoid and myeloid hemopoiesis during the early period following irradiation. This difference consisted not only in the rate at which reactions developed but in the form of the dose-effect curve and in the variations of this index with time. The lymphocyte number in peripheral blood dropped steadily from 5 min after exposure until a maximum decrease on the 2nd day. The decrease was related to an increase in radiation dose. The neutrophil number rose during the first days after irradiation, even with increased doses. A change in neutrophil number 10 min after irradiation was observed only in animals exposed to doses of 800 rads or higher. A decrease in neutrophil number was detected on the 2nd day after exposure to doses of 1000 rads and higher. Reparative processes were observed in all animals on the 3rd to 5th days and were characterized by the appearance in the peripheral blood of a large number of reticular cells, young lymphocytes, and lymphoblasts. It was concluded that a change in total leukocyte count is not an accurate index of radiation damage to the hematopoietic system but that a differential analysis is necessary for the evaluation of radiation effects on lymphoid and myeloid hemopoiesis. (C.H.)

**21832** (JPRS-24301(Del.)(p.17-22)) EFFECT OF SINGLE LOCAL IRRADIATION OF THE PERIPHERAL BLOOD VESSELS AND THEIR REACTION TO THE ADMINISTRATION OF ADRENALIN. O. V. Mikhaylova. Translated from Byul. Eksperim. Biol. Med., No. 2, 38-40(1964).

The effects of single local exposure to 100 rads x radiation on the response of peripheral blood vessels were studied in isolated rabbit ears at intervals of one to four days following irradiation. Effects on the nervous receptors were most pronounced one day after exposure as manifest by the disappearance of initial spasm and dilation of the vessels. The administration of adrenaline on the 1st, 2nd, or 4th day post-irradiation led to rapid contraction of the vessels with complete spasm lasting from 5 to 19 min followed by a return to normal. It was concluded that x ra-

diation at the dose used affects vascular tone and intensifies the response to adrenaline. (C.H.)

**21833** (OTS-63-11453/2(p.87-98)) SOME PROPERTY CHANGES IN VARIETIES OF WHEAT UNDER THE EFFECT OF VARIOUS DOSES OF X RAYS. M. Penčić and D. Jelenić. Translated from Arhiv Poljoprivredne Nauke, 16: No. 52, 94-104(1963).

The seeds of 11 varieties of wheat were exposed to x radiation at doses of 5,000, 10,000, or 15,000 r. The seeds were sown in a field five days after irradiation. Data are presented on grain yield and properties of flour and bread yield of plants grown from the irradiated seeds and controls. There was a decrease in grain yield with increase in radiation dose of all varieties. Radiation effects on flour quality and bread yield varied with the variety of wheat and content of moist or dry gluten in flour. (C.H.)

**21834** EFFECTS OF IRRADIATION ON CANINE KIDNEY. F. K. Mostofi, K. C. Pani, and J. Ericsson (Armed Forces Inst. of Pathology, Washington D. C. and Veterans Administration Central Lab. for Anatomic Pathology and Research, Washington, D. C.). Am. J. Pathol., 44: 707-25(May 1964).

The effect of radiation on the canine kidney was studied following a single dose of 2,500 r to the lower pole of the exteriorized kidney. After a latent period of four weeks the irradiated area showed peritubular congestion and hemorrhage, as well as tubular atrophy and degeneration, followed by the progressive interstitial fibrosis and, ultimately, by scarring. The experimental technique employed permitted the conclusion that the observed changes were attributable solely to the effects of irradiation and were not caused by other possible factors such as pyelonephritis, vascular disease, hypertension, or trauma. (auth)

**21835** CELLULAR AND SUBCELLULAR EFFECTS OF IONIZING RADIATIONS. P. O'B. Montgomery, David Karney, Rolland C. Reynolds, and Dale McClendon (Univ. of Texas, Dallas and Woodlawn Hospital, Dallas, Tex.). Am. J. Pathol., 44: 727-46(May 1964).

The cellular and subcellular effects of two forms of ionizing radiations were recorded by phase contrast time-lapse motion picture photography and electron microscopy. The observed functional and morphologic alterations were correlated. The studies indicated that ionizing radiations had profound effects on all cellular membranes. These effects could account for many of the important alterations in cell function observed during and after exposure to irradiation. As such, these observations serve to direct attention to the importance of the nongenetic manifestations of ionizing radiations. (auth)

**21836** PROGRESSIVE CHANGES IN CARDIOVASCULAR FUNCTION AFTER UNILATERAL HEART IRRADIATION. H. L. Stone, V. S. Bishop, and A. C. Guyton (Univ. of Mississippi, Jackson). Am. J. Physiol., 206: 289-93 (Feb. 1964). (TID-19118)

Chronic heart failure was produced by giving 20,000 r $^{60}$Co irradiation to either the right or left ventricle in nine closed-chest dogs. Measurements of right and left atrial pressures, arterial pressure, pulse rate, body weight, and blood volume were made before and after irradiation. The right and left atrial pressures rose progressively until death in three animals irradiated on the right side. In six animals irradiated on the left side, the left atrial pressure rose progressively, but the right atrial pressure either did not rise or rose only during the latter stages of failure. Declining arterial pressure and increasing pulse rate were common to both groups. Increases in blood volume were observed in all animals, but this increase was significant only in the group irradiated on the left side. At autopsy, 70 to 100% of the right ventricular muscle was damaged in dogs irradiated on the right side, and 40 to 70% of the left ventricle in dogs irradiated on the left side. Hydrothorax and liver congestion were found in the right-sided group and pulmonary congestion in the left-sided group. (auth)

**21837** DISTURBANCE IN BONE GROWTH PRODUCED BY 3.5 Mev ELECTRON IRRADIATION OF YOUNG RABBIT LIMBS. Giulio J. D'Angio (Children's Hospital Medical Center, Boston), Joachim Jung, Kenneth A. Wright, and Jonathan Cohen. Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 1132-7(May 1964).

The effects of high energy x irradiation and electron irradiation on the growing knees of young rabbits were compared experimentally. The principal abnormality in those animals receiving x irradiation was shortening of the treated limbs, while in those irradiated with electrons, it was genu varum. (auth)

**21838** THE VASCULARIZATION OF ADRENAL TRANSPLANTS IN THE RAT AND THE EFFECT OF X-IRRADIATION. Leland C. Wyman, I. A. Macchi, Donald I. Patt, and Brenda Shaw (Boston Univ.). Anat. Record, 147: 533-45(Dec. 1963).

Vascularization of subcutaneous (ear) and mesenteric adrenal autografts, homografts, and x-irradiated autografts was studied microscopically through visualization of small blood vessels by intravascular precipitation of lead chromate. Vascularization of autografts in both sites begins on the third day after transplantation with a surface network of small vessels. Vascular buds penetrate the graft on the fourth day. On the seventh vascularization is complete. Vessels penetrate along regenerated adrenocortical fasciculi. Later, large vessels supplying the network around the graft are prominent and venous sinuses exist near the surface. Vascularization of subcutaneous homotransplants follows the same qualitative course but is chronologically irregular, delayed one or more days in most cases. On the second day an inflammatory vascular reaction occurs around the wound in the ear. Generally, vessels are finer, less well injected than in autografts. Mesenteric homografts, however, are vascularized like mesenteric autografts. X irradiation of adrenals in vitro with 2,000 r prior to autografting also produces chronological irregularity and retardation of vascularization, up to 28 days after subcutaneous transplantation, but only during the first 12 days in mesenteric transplants. Except for reduction in size, from the thirteenth day on, x-irradiated mesenteric transplants are like nonirradiated controls. (auth)

**21839** ON THE INITIAL SITE OF THE MUTAGENIC ACTION OF X AND ULTRAVIOLET RAYS ON ESCHERICHIA COLI K12. T. Kada and H. Marcovich (Institut Pasteur, Paris). Ann. Inst. Pasteur, 105: 989-1006(Dec. 1963). (In French)

Attempts were made to establish the primary gene locus by analysis of transmission of genetic characters from strain Hfr male bacteria to $F^-$ female bacteria. Reversions to prototrophy induced by x and uv radiations were studied by genetic recombination in these threonineless strains. The male and female cells were respectively Hfr $thr^-leu^+S^sT6^s$ and $F^-thr^-leu^-S^rT6^r$, possessing the same $thr^-_{33}$ allele. In a cross between these two nonirradiated strains, the $thr^+$ $leu^+S^sT6^r$ recombinants can be primarily attributed to half of the spontaneous $thr^+$ revertants of the

Hfr cells. X or uv irradiation of Hfr cells increases the frequency of $thr^+$. These cells remain Hfr and are able to transmit to the recombinants the $leu^+$ character with a normal high frequency. With uv, if the cross is performed immediately after irradiation, no induced prototrophic character is transmitted; however, the induced character is transmitted if the irradiated males are incubated for several hours in broth before mating. With x rays, ~50% of the induced character is immediately transmissible. If the female cell is uv irradiated and then crossed with a male, the genetic material injected by the male into the female is induced to mutate, but this effect is not observed with x rays. It is suggested that x rays may act directly on the chromosome to induce mutations, and that uv light acts via an indirect step. (BBB)

**21840** THE INFLUENCE OF ZYMOSAN, CORTISONE, AND X RAYS ON THE COURSE OF EXPERIMENTAL TOXOPLASMOSIS IN WHITE RATS. Mieczyslaw Metzger, Andrzej Przerwa-Tetmajer, and Zygmunt Wojciechowski (Inst. of Immunology and Experimental Therapy, Wroclaw, Poland). Arch. Immunol. Terapii Doswiadczalnej, 11: 227-33(1963).

In rats treated with zymosan or cortisone, toxoplasma organisms were found in the blood 20 or 28 days after infection, whereas in control animals parasitemia did not last longer than 10 days. The influence of x rays on toxoplasmosis was studied in animals infected with toxoplasma organisms one day after a single x irradiation with a whole-body dose of 600 r. All the irradiated and infected rats died between the 14th and 22nd day after infection; during this entire period blood examinations disclosed presence of toxoplasma organisms in peripheral blood. They were also found in organs of these animals. On the other hand, in the blood of infected but not irradiated animals, toxoplasma organisms were present in the blood only up to the 10th day after infection, and these animals survived longer than 90 days. The irradiated but noninfected animals survived the 3-month period of observation without showing any symptoms of disease. Thus zymosan, cortisone, and x rays modify the course of experimental toxoplasmosis in rats. To obtain further information on the mechanism of the action of these agents, a study was undertaken of their influence on some of the properties of the serum which might be important in the defense against toxoplasma infection (normal human and animal sera exhibit antitoxoplasma activity due to the presence of the so-called Jettmar factor, which in vitro produces a cytopathogenic effect on the parasites). In rats, guinea pigs, and mice, levels of Jettmar's factor were determined, and animals were selected whose serum damaged more than 75% or less than 30% of the toxoplasma organisms tested. It was found that all animals with strong serum antitoxoplasma activity tolerated the infection, surviving to the end of the 3-month period of observation, although their organs secured at autopsy contained toxoplasma organisms. In contrast, all animals with low levels of Jettmar's factor (less than 30% damaged organisms) developed acute toxoplasmosis and died after 6 to 18 days. The time of survival of these animals was approximately proportional to the antitoxoplasma activity of their sera. The influence of zymosan, cortisone, and x rays on the levels of Jettmar's factor was studied. A single injection of 25 mg of zymosan in rats within 30 min caused a drop in the levels of Jettmar's factor to approximately 30% of the initial levels, lasting for several hours and then gradually rising; after 24 hr; however, the levels were still only half the initial ones. After 48 hr the levels returned to normal in all the animals. The activity curve after injection of cortisone had a similar shape, although the drop was less pronounced than after zymosan. The animals irradiated with 600 r did not show any changes in the levels of Jettmar's factor during observation for 30 days. Since irradiation did not affect the level of Jettmar's factor in the serum, its mode of action is evidently different than that of zymosan and cortisone. To explain this difference, it is proposed that zymosan and cortisone enable the organisms to multiply in the body by suppressing the activity of the toxoplasma-hostile factor in the serum, whereas irradiation impairs the ability of phagocytes to destroy the parasites, making possible their uninhibited multiplication in these cells. (BBB)

**21841** THE INFLUENCE OF X-RAYS ON EXPERIMENTAL HISTAMINE SHOCK (PRELIMINARY REPORT). Stanislaw Kosmider and Edmund Rogala (Silesian School of Medicine, Zabrze, Poland). Arch. Immunol. Terapii Doswiadczalnej, 11: 235-7(1963).

Guinea pigs were exposed to 100-r, whole-body doses of x rays (160-kv, 25 r/min), and 3, 7, or 10 days later were subjected to histamine shock. Shock was induced by intracardial injection of 0.5 mg histamine hydrochloride/kg body weight. In the control group of unirradiated animals the injection of histamine caused death of all the animals within 6 to 10 min with signs of shock. Of the six irradiated guinea pigs which received the intracardial injection of histamine on the 3rd day after exposure to x rays, only one animal died, the remaining five exhibiting signs of shock. In the second group, in which shock was evoked on the 7th day after irradiation, two animals died, and in the group in which histamine was administered on the 10th day, four animals died. Hence, irradiation diminishes the sensitivity of guinea pigs to histamine injected intracardially, the lowest sensitivity level occurring after three days, followed by a gradual rise. The mechanism of this phenomenon is not clear, but it is suggested that in histamine shock morphologic lesions leading to death are probably the result of inhibition of tissue respiration due to blocking of the tissue respiratory enzymes by histamine: presumably, during the early stage of radiation disease the cells are protected from lethal histamine shock as a result of histamine, being a strong stimulus, diminishing sensitivity to a second stimulation by other shock-producing factors, in spite of the fact that histaminase activity is distinctly suppressed. The phenomenon can also be explained on the basis of the theory of general adaptation and the finding that radiation stimulates the pituitary-adrenal axis, intensifying the activity of the cortical hormones which prepare the body for other stimuli (histamine). Other changes observed after irradiation were lowered serotonin levels or changes in nervous reactivity and lowered threshold of sensitivity of the enteroreceptors. (BBB)

**21842** ALTERATION IN THE SEQUENCE OF DEOXYRIBONUCLEIC ACID SYNTHESIS BY EXPOSURE TO ULTRAVIOLET LIGHT. Roger Hewitt and Daniel Billen (Univ. of Texas, Houston). Biochem. Biophys. Res. Commun., 15: 588-97(May 6, 1964).

Experiments were undertaken to study the orientation of DNA synthesis in E. coli strain $15T^-$ after uv irradiation. Data are presented showing that a relatively low dose of uv alters the order of DNA replication. (auth)

**21843** CONTROL OF SEED BORNE DISEASES BY RADIOACTIVE IRRADIATION. T. C. Lo (Provincial Chung Hsing Univ., Taiwan, China). Botan. Bull. Acad. Sinica (Taiwan), 5: 1-16(Jan. 1964).

Results of studies on the control of seed-borne disease

by radioactive irradiation are presented. The seed-borne diseases and pure culture of their causal organisms used in this investigation were spot blotch of barley (Cochliobolus sativus), brown spot of rice (Cochliobolus miyabeanus), and purple stain seed of soybean (Cercospora kikuchii). The diseased seeds were irradiated under gamma radiation obtained from the $^{60}$Co source with different dosages. The results obtained from this investigation indicated that high dosage level radiation could inhibit the germination of seeds. In general, the pathogens were more resistant to irradiation than their respective hosts. The mutants of tested pathogens were induced by irradiation. The minimum lethal dosage was not worked out owing to the lack of high dosage level source. Nine mutants of Cochliobolus sativus were induced. These mutants exhibited differences in growth character and morphology of spores. The conidia of Cochliobolus miyabeanus germinated freely after exposure to dosage up to 60,000 $\gamma$ dosage level. The purple pigment from Cercospora kikuchii was visible around the outer part of colonies obtained from nonirradiated seed whereas it could be found only under the colonies of irradiated ones. The influence of irradiation on the growth of soybeans was very significant. The leaves of variant plants of soybean were rugose, small, narrow and light green in color. The growth and podding of an irradiated soybean plant decreased in inverse proportion to the increase of the irradiation dosage. Results confirmed that seed-borne diseases could not be controlled by means of irradiation. (auth)

**21844** POST UV IRRADIATION EFFECT ON ASPERGILUS TERREUS. A MORPHOLOGICAL AND BIOCHEMICAL STUDY OF THE AGED UV-INDUCED VARIANTS. June C. Y. Tsao (Taiwan Provincial Cheng Kung Univ., China). Botan. Bull. Acad. Sinica (Taiwan), 5: 26-35(Jan. 1964).

This work was a continuation of previous investigation on the uv-induced variations in Aspergillus terreus. Sixteen one yr-old morphologically different variants induced by 2537 Å uv dosages ranging from $4.518 \times 10^5$ to $9.036 \times 10^5$ ergs/mm and stored under unfavorable environment were twice resubcultured on new Underkofler's agar slants and incubated at 32 ± 1°C for 10 days. A morphological study of the subcultures was able to screen out five stable variants. The stable variants grew with undiminished vigor and had well-formed conidial heads. Poor variants had pink, red, or changeable colors and died out after a year's storage. Intermediate variants were not stable strains because they had changeable colors and did not have good conidial heads for reproduction. A comparative study of the biochemical activities in the production of itaconic acid from molasses also revealed the fact that the morphologically determined stable variants were also the good itaconic acid producers. The poor acid producers were the ones which could not resist the long storage. It is suggested that a fundamental clue for determining the radioinduced mutations must rely on studying the messenger RNA and genetic information carrier DNA. (auth)

**21845** PRESENT CONCEPTS ON THE PATHOLOGIC PHYSIOLOGY OF LYMPHOCYTES. A. Hromec (Komenskeho Univ., Bratislava). Bratislav. Lekarske Listy, 2: 354-70(1963). (In Czech)

A review, with 139 references, is presented including consideration of the effects of ionizing radiations on lymphocytes. (BBB)

**21846** RADIATION AND LEUKEMIA. Brit. Med. J., 1: 383-4(Feb. 15, 1964).

A brief survey is made of the evidence relating to the possible leukemogenic action of radiation as received by diagnostic and therapeutic exposures. The steady rise in deaths from leukemia that has been recorded throughout the world in the past decades is commented on. In England and Wales between 1945 and 1961 the number of deaths from leukemia apparently increased by more than 50%. For both acute and chronic lymphatic leukemia the increase occurred almost entirely in persons over 65, most probably owing to improved medical care and diagnosis and more accurate certification of the cause of death. By contrast, other forms of acute leukemia and chronic myeloid leukemia became more frequent in younger adults over this period, and this suggests that factors causing leukemia may have become more prevalent in our environment. It is pointed out that several studies have concluded that large doses of radiation increase the incidence of leukemia, and that this increase is confined to acute leukemia and chronic myeloid leukemia. (BBB)

**21847** MEDICAL RADIATIONS AND LEUKEMIA: A RETROSPECTIVE SURVEY. F. W. Gunz and H. R. Atkinson (Christschurch Hospital, New Zealand). Brit. Med. J., 1: 398-93(Feb. 15, 1964).

A survey was made of the histories of 590 patients with leukemia to compare the patients' experiences of ionizing radiation with those of a series of matched controls, and to assess the degree to which radiation exposure could have been responsible for the causation of the disease. Radiation histories were compiled from the recollection of either the patients or their relatives or both, and confirmed from hospital records (in all but a few instances). Treatment by means of x rays or radioisotopes had been given to 47 patients subsequently found to have leukemia, to seven with myelomatosis, and to 38 controls. Twenty-two of the isotope cases had been treated with Ra, four with $^{131}$I, two with $^{32}$P, and one with $^{106}$Ru. Integral and/or bone-marrow doses were calculated. The results show that 26 of the leukemia patients and 23 of the control patients had received radiotherapy at integral doses of less than 1.5 mega-g r, while 22 leukemia and 24 control patients had had marrow doses below 10 r. In contrast with this low-dose group, 17 leukemia patients and only seven controls had received integral doses over 1.5 mega-g r, while 23 leukemias but only 11 controls had had marrow doses above 10 r. Twenty leukemia patients but only four controls had had therapeutic doses of more than 1.5 mega-g r (integral) or 10 r (marrow) within the preceding 15 yr. In acute and chronic granulocytic leukemias the incidence of radiotherapy exposure was 3.8% compared with 0.6% in controls, representing a significant excess of ~3%. From a consideration of diagnostic irradiation during the 10 yr preceding the onset of the disease, it is seen that 49% of patients with acute leukemia, 72.9% with chronic granulocytic leukemia, 62.3% with chronic lymphocytic leukemia, 55.8% with myelomatosis, and 61.2% of controls had received diagnostic radiation. The approximate skin doses and the marrow doses for the 116 patients with skin doses in excess of 10 r were calculated. This showed that the percentage of high-dose cases in the chronic granulocytic group was double that in the controls. Also, the average dose in chronic granulocytic leukemia was higher than that in the other groups. Information on diagnostic radiation given to the mother during the pregnancy which led to the birth of an affected child was available for 102 leukemic children under 15 and for only 89 controls, but fetal doses could not be calculated in any of these cases. The total number of children in this survey was too small to indicate

whether the slight excess of irradiation among leukemia patients (13.7% against 12.3% in controls) was significant. It was concluded that the patients with acute and chronic granulocytic leukemia showed greater exposure to radiotherapy than controls, the excess amounting to nearly 3%, and that if diagnostic radiation was concerned in the etiology of any cases, it seemed unlikely that their number could exceed 1%. (BBB)

**21848** GAMMA IRRADIATION OF APPLES. W. R. Phillips (Food Research Inst., Ottawa). Can. Food Ind., August 1963. (AECL-1890(p.39-41))

Gamma irradiation is being used in many ways. In food processing it is used as a sterilizing agent; in medicine as an inhibitor of tumor growth; by plant breeders as a means of altering chromosome structure and more recently as a sprout inhibitor for potatoes and onions. There are other lesser known applications, one of which is the effect of irradiation on dormant or inactive plant material. This includes the effect on fruits in general and more specifically on apples. The first finding in irradiating apples was that they could withstand much higher dosage levels than humans, higher animals, or the growing organs of plants. For example, 500 to 1500 rad is considered lethal for higher animals and growing tissue in plants whereas apples will withstand 100,000 rad and still live in an almost normal manner, excepting the fact that seed germination is impaired. In one of the storage projects it was noted that the occurrence of certain storage disorders appeared to be stimulated by seed activity. This suggested that gamma irradiation might be a useful means of inhibiting seed activity and thereby controlling the development of storage disorders without damaging the apples. These initial findings appeared to be sufficiently encouraging to justify a fairly large scale project. (auth)

**21849** EFFECT OF GAMMA RADIATION ON THE UTILIZATION OF WHEAT STRAW BY RUMEN MICROORGANISMS. G. I. Pritchard, W. J. Pigden, and D. J. Minson (Canada Dept. of Agriculture, Ottawa). Can. J. Animal Sci., 42: 215-17(Dec. 1962). (AECL-1890(p.62-4))

The effects of gamma radiation from $^{60}Co$ upon the feeding value of wheat straw were determined by in vitro fermentations with rumen microorganisms. Exposure of the straw to dosages of $1 \times 10^7$ rads caused a slight increase in dry matter digestion whereas exposures of $1 \times 10^8$ rads or more caused a marked increase. The solubility of straw was also increased with dosages of $1 \times 10^8$ rads or more. However, increases in the volatile acid production from the fermentations were found only up to dosages of $2.5 \times 10^8$ rads, suggesting that above this level of radiation the carbohydrates are disintegrated to such a degree that they are no longer suitable substrates for rumen microorganisms. These findings confirm the presence of nutrients entrapped in wheat straw which can be made available to the rumen microorganisms, but the levels of gamma irradiation necessary for their release are well above what is practical for commercial operations. (auth)

**21850** CONCERNING THE INFLUENCE OF HEAD IRRADIATION ON THE DEVELOPMENT OF RADIATION DAMAGE IN THE RAT THYMUS. J. F. Scaife (Defence Research Chemical Labs., Ottawa). Can. J. Biochem., 42: 623-9(May 1964).

Early radiation damage in rat thymocytes was assessed at 4 and 24 hr following varying doses of whole-body irradiation and compared with the effects produced by a dose of 1000 rads to the head only of the animal. The indirect does to the shielded thymus in these head irradiation experiments was found to be 22 rads. The criteria employed to assess the radiation damage were: changes in wet weight, DNA content, pyknosis, $^{51}Cr$ uptake, supernatant NADase alkaline RNAase and soluble RNA and nucleotide content of the thymus. No radiation damage beyond what could be expected from scattered irradiation was produced in the thymus by head irradiation only. Adrenalectomized and hypophysectomized animals showed no difference in their response to whole-body irradiation as compared to unoperated controls. It is concluded that the adenohypophysis response of irradiation is not involved in the death or damage of thymocytes following low doses of whole-body irradiation. (auth)

**21851** SOME EFFECTS OF GAMMA RADIATION ON STORED ONIONS. V. M. Nuttall (Canada Dept. of Agriculture, Ottawa); L. H. Lyall, and K. F. McQueen. Can. J. Plant Sci., 41: 805-13(Oct. 1961). (AECL-1890(p.30-8))

Gamma radiation doses of 3200, 4700, 6300, 7900, and 9500 rad completely inhibited sprouting of Brigham Yellow Globe onions in a 300-day test period during which 75% of the nonirradiated controls sprouted. In a second test of equal duration, using controlled temperature storage and shed storage, less than 3% of Autumn Spice onions exposed to either 4000 or 8000 rad sprouted, whereas more than 79% of the nonirradiated bulbs sprouted. Irradiation reduced sprouting of Yellow Sweet Spanish onions in both tests. Some evidence indicated that the smaller bulbs in both the irradiated and nonirradiated lots were less susceptible to storage rot. In Brigham Yellow Globe, the incidence of internal discoloration of the growing point was suggested with the highest radiation dose. Irradiated onions were milder in flavor. (auth)

**21852** INFLUENCE OF GAMMA RADIATION ON THE DEVELOPMENT AND FERTILITY OF THE CODLING MOTH, CARPOCAPSA POMONELLA (L.) (LEPIDOPTERA: OLETHREUTIDAE). M. D. Proverbs and J. R. Newton (Canada Dept. of Agriculture, Summerland, B. C.). Can. J. Zool., 40: 401-20(1962). (AECL-1890(p.65-81))

Exposure of the mature pupa or the newly emerged adult of the codling moth, Carpocapsa pomonella (L.), to 40,000 rads of gamma radiation induced dominant lethality in at least 98% of the sperm without affecting adult emergence, mating behavior, or adult longevity. Higher dosages decreased the frequency of mating. Irradiation of eggs, mature larvae, or young pupae induced dominant lethality in a high percentage of the sperm, but caused prohibitively high mortality and frequently reduced mating. The female was more radiosensitive than the male. In general, sensitivity decreased as development progressed from the egg to the adult stage. (auth)

**21853** OCCUPATIONAL RADIODERMATITIS DUE TO WORK WITH RADIOACTIVE LUMINESCENT PAINTS ($Sr^{90}$). L. Jirasek and O. Juren (Charles Univ., Prague). Cesk. Dermatol., 36: 91-4(Apr. 1961). (In Czech)

**21854** A FURTHER REVIEW OF REPORTS ON THE LATE EFFECTS OF ATOMIC BOMB EXPLOSIONS IN HIROSHIMA AND NAGASAKI. S. Akimoto, K. Honda, N. Kusano, H. Nakamura, and H. Shiga (New Japanese Doctor's Assn., Hiroshima). Cesk. Zdravotnictvi, 10: 466-79(Sept. 1962). (In Czech)

**21855** ACTION OF X RADIATION ON POTASSIUM TRANSFER BY "GHOSTS" OF HUMAN RED BLOOD CORPUSCLES. Jean Philippot (Laboratoire de Physiochimie Biologique de la Faculte de Medecine, Montpellier, France). Compt. Rend., 258: 3133-6(Mar. 16, 1964). (In French)

Structures with $K^+$ transfer properties similar to red blood corpuscles were obtained by hemolysis of red blood corpuscles by strongly hypotonic solutions. These "ghosts" were then used to study the effects of x radiation on the active transfer of $K^+$. (D.C.W.)

**21856** CHROMATID-TYPE ABERRATIONS INDUCED BY X RAYS IN HUMAN LEUKOCYTE CULTURES. M. A. Bender and P. C. Gooch (Oak Ridge National Lab., Tenn.). Cytogenetics, 2: 107-16(1963).

Cultures were made of peripheral blood leukocytes of four human donors and the 66-hr-old cultures were x irradiated (25 to 100 r). The cells were fixed in metaphase six hr later by adding colchicine and examined for chromosomal abnormalities. The observed aberrations were largely of the chromatid type (deletions and exchanges), but five examples of undoubted chromosome-type aberration were also seen in the irradiated material. These were all abnormalities of chromosome length or of centromere position which can arise either as a result of symmetrical translocation or of pericentric inversion. No dicentrics or rings were seen. It is thus probable that a small proportion of the leukocyte mitoses sampled in the 6-hr postirradiation period contained at least a few unsplit chromosomes or chromosome regions at the time of irradiation. This finding is compatible with the previous observation that the post-DNA-synthesis period ($G_2$) in this system is less than 6 hr and with the finding that only chromatid aberrations were induced in human leukocyte cultures irradiated four hr before fixation. The dose-effect relation for chromatid breakage is represented by the slope of the regression of chromatid breaks on dose. The regression is calculated from the expression: $Y = a + bD$, where Y is the yield of breaks, D the dose, a the spontaneous breakage frequency, and b the coefficient of breakage production. When chromatid deletions and isochromatid deletions are both scored as single breaks (even though a few isochromatid deletions must represent two independent breakage events) and each chromatid exchange is scored as two breaks, least-squares fits of the data yield: $Y = 0.32 + 0.0031\ D$ (if achromatic lesions are excluded). The data yield values of 0.0015 chromatid deletions/cell/r and $0.0015 \pm 0.0001$ isochromatid deletions/cell/r. The coefficient of breakage production (0.0031) found in the present studies was compared with those found in other studies of human chromatid-type chromosome breakage, for example, 0.0032 in x-irradiated human kidney cells in vitro. The marked difference between these results is interpreted as a difference in radiosensitivity between the epithelioid and the fibroblast types of cultures. Thus, human leukocytes in short-term culture clearly behave like the epithelioid cells in culture with respect to x-ray-induced, chromatid-type aberrations. The coefficients of aberration production found in the present experiments are also compared with the values obtained previously for human chromosomes and with those calculated for the plant material. It is seen that while values for chromatid deletions in human kidney cells and in human leukocytes agree fairly well, the data for human skin cells and for Tradescantia give much higher values. The values for isochromatid deletions, on the other hand, all agree fairly well. (BBB)

**21857** NEW MATERIAL FOR THE STUDY OF EPIDERMAL CYST FORMATION: CYSTS FOLLOWING X-RAY IRRADIATION IN GUINEA PIGS. G. Maggiora (Hôpital Cantonal, Geneva). Dermatologica, 128: 22-6(1964). (In French)

Nine guinea pigs were exposed to 1600 r of 50-kv x rays on one flank, and six others were irradiated on both sides. These animals were irradiated again two months later with the same dose, and after an interval of one month a biopsy made of the affected skin regions. Histologic sections showed the presence of a relatively large number of epidermal cysts in 3 out of 15 animals. Of these, one had been exposed only on one flank. Of two animals exposed on both flanks, one presented cysts on one side alone, the other on both sides. The cysts originated in the pilosebaceous region. A relatively high x-ray dose appears necessary for their formation; in previous experiments in which guinea pigs received a single dose of 1600 r, only one cyst was found in 50 histologic preparations. The presence of retention cysts has been described in human patients exposed to skin irradiation in high doses (2000 to 6000 r). In some of these clinical examples, histologic sections have shown the presence of papillomatosis as well as epidermal cysts. The occurrence of cysts in humans, produced under similar conditions to those of experimental animals, suggests the possibility of using this method to provide a new source of material for the study of epidermal cyst formation. (BBB)

**21858** ON THE MECHANISM OF ACTION OF CARCINOGENIC FACTORS. H. Dannenberg (Max-Planck Institut für Biochemie, Munich). Deut. Med. Wochschr., 88: 605-16(Mar. 19, 1963). (In German)

The possible means by which various chemical and physical agents, including ionizing radiations, may induce cancer, are discussed. (BBB)

**21859** THE EFFECT OF X-RAY IRRADIATION ON THE CONTENT OF COENZYME A IN THE BONE MARROW OF RATS. V. N. Filippova and I. F. Seits (Leningrad Research Inst. for Blood Transfusion). Dokl. Akad. Nauk SSSR, 154: 1210-3(Feb. 11, 1964). (In Russian)

It is hypothesized that enzyme systems containing the sulfhydryl group such as coenzyme A are most sensitive to irradiation. Hence, rats weighing 150 to 200 grams were given an x-ray dose of 1000 to 1300 r, and the coenzyme A content in the extracted bone marrow was determined at two and four hr, and one, two, and three days after the irradiation. The coenzyme A content was determined from the amount of acetyl-sulfanilamide formed in an enzyme system containing $6 \times 10^7$ bone marrow cells. A sharp drop of 50% in coenzyme A content was noted four hr after irradiation. The coenzyme A content remained at this reduced level for one, two, and three days after the irradiation. The administered x-ray doses was a lethal dose, and the rats died from the effects of the irradiation before a drop of greater than 50% in coenzyme A content could be observed. It is considered significant that the drop in coenzyme A content can be observed four hr after the irradiation. (TTT)

**21860** THE ECONOMIC AND TECHNICAL SIGNIFICANCE OF IRRADIATION PRESERVATION OF FOOD. J. Farkas and I. Kiss (Central Research Inst. of the Food Industry, Budapest). Elelm. Ipar, 16: No. 1, 1-8(Jan. 1962). (In Hungarian)

The nature of nuclear irradiations and their production either by radioisotopes, especially $^{60}Co$, or by particle accelerators such as the Van de Graaff generator are discussed. An irradiation installation which is used for food preservation is described. The bactericide effects of these radiations are due to the physical and chemical changes brought about by ionization of the medium in which the bacteria live and depend largely on the nature of the microorganisms and environmental conditions such as tempera-

ture, presence of O, water, minerals, etc. The necessary doses varied over a wide range from 5–10 krad to 2–100 Mrad. The doses necessary to destroy or inactivate several important microorganisms that produce food spoilage are indicated. Finally, the practical realization of irradiated preservation of foods is outlined, and an estimate is made of radiation sources, manpower, and equipment required, the cost factor being noted in comparison with preservation costs of competitive food industries working by customary procedures. (OID)

**21861** THE EFFECTS OF RADIATION ON ENZYMES IN TISSUE CULTURES. P. Verani, D. Balducci, M. A. Chibbaro, M. Chiozzotto, S. Perugini, and G. Penso (Istituto Superiore di Sanita, Rome). Experientia, 20: 154-6 (1964).

Morphological and biochemical aspects of sublethally irradiated and non-irradiated cells were investigated to see whether differences are detectable. Rhesus monkey kidney cells were used; cultures were x irradiated with 300, 1000, and 3000 r. It was concluded that after irradiation with 300 and 1000 r alkaline phosphatase activity increases while acid phosphatase does not differ in behavior from normal cells. The increased activity of the alkaline phosphatase reached a maximum on the 2nd day after irradiation when the growth rate began to decrease. Considering the diffuse distribution of alkaline phosphatase in the cells the increased activity of this enzyme could be the expression of an early generalized stimulation or lesion that later disappears. (P.C.H.)

**21862** STERILIZATION OF MEDICINAL PREPARATIONS WITH GAMMA RADIATION. M. Penova and V. Kushev. Farmatsiya (Sofia), 13: 11-17(July-Aug. 1963). (In Bulgarian)

A review with 26 references is given. (BBB)

**21863** FOOD IRRADIATION IN AUSTRALIA. W. J. Scott (Commonwealth Scientific and Industrial Research Organization, Ryde, Australia). Food Irradiation, 2: No. 4, A4-5(Apr.-June 1962).

All food irradiation research in Australia is carried out at the A.A.E.C. Research Establishment at Lucas Heights. Radiation sources are an underwater $^{60}$Co irradiator which soon will have a strength of 10,000 C, a fuel element of 100 Mrad/cc/day, and a small Van de Graaff accelerator. At Dandelong near Melbourne, a very large $^{60}$Co source (500,000 C), operated commercially for disinfecting animal hair, will also be available for food irradiation. Presently, food preservation is investigated at a low dosage of $10^4$ rads at which level no organoleptic changes are detectable. Interest is concentrated on the preservation of fruits which are often infested with the Queensland fruitfly Strumeta tryoni. Dosages of 10,000 rads, which are necessary to kill the insect, have not produced noticeable organoleptic changes in citrus fruits. Dosages of 5,000 rad control the sprouting of potatoes under Australian conditions for 6 months. However, the introduction of the commercial irradiation of food must await acceptance by the Public Health Authority which carries out experiments with irradiated foods on animals. (auth)

**21864** PUSH FOR PROGRESS IN FOOD IRRADIATION. Ferdinand P. Mehrlich (Armed Forces Food and Container Inst., Natick, Mass.). Food Process., 24: 84-9(May 1963).

Also appears Reprinted as p.133-9 of "Review of Army Food Irradiation Program, Hearing, JCAE, May 13, 1963." GPO($1.50).

The Army food irradiation facility at Natick, Massachusetts is described. Two sources of radiation, $^{60}$Co gamma and an electron accelerator, are used at Natick. Dosage control is discussed in terms of packaging for both sources. The importance of basic and applied radiation microbiology to the food irradiation program is pointed out. It was determined that on the basis of Clostridium botulinum spores, satisfactory food sterility can be achieved using 4.5-Mrad doses. Results of irradiated meat acceptance tests conducted at Fort Lee, Virginia, are tabulated. (H.M.G.)

**21865** MODIFICATIONS OF THE THROMBOELASTOGRAM IN THE IRRADIATED RABBIT (ANALOGIES TO OCCUPATIONAL EXPOSURE IN MAN). Claude Levy (Institut du Radium, Paris). Hemostase, 3: 59-65(Mar. 1963). (In French)

Thromboelastography (TEG) was used to study modifications in blood coagulation in rabbits subjected to whole-body x irradiation with doses approaching those considered as permissible exceptional occupational exposures in man, 25 and 50 r, as well as a much higher dose, 950 r. Results showed that distinct modifications of the tracings were produced even with the lower doses. All three of the TEG parameters (reaction time, coagulation time, and maximum amplitude) were altered. These changes, indicating radio-induced hypocoagulability of blood, were the same for all doses at the 10th or 11th day, and appeared at the 7th day after 950 r. The cause of these modifications could not be attributed in all cases solely to platelet damage. At present it is not known whether doses of 25 to 50 r are injurious to man, but the results obtained here indicate that TEG may be of value as a technique for systematically following blood coagulation disorders in workers exposed to ionizing radiations. (BBB)

**21866** ON THE SOCIAL IMPORTANCE OF FETAL CHANGES AND ABNORMALITIES CAUSED BY RADIATION. Luigi Della Corte (Università, Naples). Igiene Mod. (Parma), 54: 623-30(Sept.-Oct. 1961). (In Italian)

**21867** RADIATION-INDUCED SPIKELET ABNORMALITIES AND MUTATIONS IN RICE. P. Narahari and K. C. Bora (Atomic Energy Establishment, Trombay, India). Indian J. Genet. Plant Breeding, 23: 7-18(Mar. 1963).

Unhusked and dry seeds of Oryza sativa varieties were exposed to $1\times 10^{12}$, $2.5\times 10^{12}$, $5.0\times 10^{12}$, and $1\times 10^{13}$ np/cm$^2$ of pile neutrons. Abnormalities observed in the spikelet and a few variable mutants were studied. Abnormal spikelets observed in the first generation included elongation of sterile glume, polyhusks, inverted spikelets, and clustered spikelets. Other abnormalities also appeared in the first generation. Second and third generation mutants were open spiked mutant, tipped grain mutant, early and purple mutant, chlorophyll chimeras, short-culmed and non-lodging plants, and incurved lamina mutant. (H.M.G.)

**21868** RADIATION INDUCED MUTATIONS IN GROUNDNUT. I. CHLOROPHYLL MUTATIONS. S. H. Patil and K. C. Bora (Atomic Energy Establishment, Trombay, India). Indian J. Genet. Plant Breeding, 23: 47-9(Mar. 1963).

X-ray induced xantha and virescent mutants were studied in $X_4$ and $X_5$ generations of Arachis hypogoea $X_5$ plants in the progenies segregated for normal and virescent types in ratios ranging from 1:1 and 15:1, indicating that the development of chlorophyll in groundnut was possibly controlled by more than one gene locus. (auth)

**21869** SOME X-RAY INDUCED AND SPONTANEOUS MUTATIONS IN CICER. D. S. Athwal (Punjab Univ., Chandigarh, India). Indian J. Genet. Plant Breeding, 23: 50-7(Mar. 1963).

Doses of 3,000 and 4,500 r x radiation were sometimes

lethal for germinated and soaked seeds of Cicer arietinum. The percentage of total germination decreased and the number of days taken to germinate increased with higher doses of radiation. A number of mutations were induced by irradiation of the seeds. Some of the radioinduced mutations resembled spontaneous mutations found in wild plants. (C.H.)

**21870** BONE DISEASE INDUCED BY RADIATION. Janet Vaughan (Churchill Hospital, Oxford). Intern. Rev. Exptl. Pathol., 1: 243-369(1962).

The effects of radiation, from both external and internal sources, on bone are reviewed. Evidence gained in the last five years has revealed the following general principles regarding radioinduced bone pathology: although there is often an association between radiation dysplasia and radiation neoplasia, this relation may not necessarily be a causal one; radiation dose is an effective factor in promoting radiation neoplasia in bone only if other tissue conditions are favorable; the tissue at risk, as far as neoplasia is concerned, is probably the osteogenic connective tissue, particularly on endosteal surfaces. The statement that bone changes produced by external irradiation differ from those produced by internal deposition of radioactive materials is disputed. The pattern of injury may be different but the fundamental pathologic lesions are the same. The characteristic picture of radiation dysplasia resulting from different types of radiation is discussed in detail and illustrates the evidence on which the above general conclusions are based. The question of the relation of radiation dysplasia to radiation neoplasia is also discussed. It is suggested that the repair process, usually resulting in a more rapid cell turnover or a larger proliferative pool, may disclose an otherwise long latent carcinogenic event, be it a somatic mutation or virus mediated. Factors other than radiation dose are suggested as important in determining the occurrence of carcinogenesis. The evidence, which is discussed in describing radiation effect on bone, suggests that both direct effects on bone cells and secondary effects due to vascular damage are responsible for radiation dysplasia, but there is no evidence to indicate whether vascular damage plays any part in carcinogenesis in bone. Also discussed are the nature of radiation sources to which bone may be exposed, dosimetry, bone-seeking radioisotopes, and the kinds of tumors produced in bone by radiation. (BBB)

**21871** ON THE CHEMICAL BASIS OF THE BIOLOGICAL ACTIONS OF IONIZING RADIATIONS. G. Stein (Hebrew Univ., Jerusalem). Israel J. Chem., 1: 445-50 (Dec. 1963).

Water, present in irradiated biological systems may modify the radiation effects, compared with dry solids, both in direct and in indirect action. The possible role of solvated electrons in such reactions are discussed. Model systems are described in which, without the assumption of energy transfer, the action of ionizing radiations is concentrated on suitable acceptors present in low concentration ($10^{-5}$ M ferricyanide or cytochrome C) in the presence of up to 20% gel-forming protein, such as gelatine. Oxygen effects are described. (auth)

**21872** SEMIEMPIRICAL SCF-LCAO-MO CALCULATION OF THE ELECTRONIC STRUCTURE OF THE GUANINE–CYTOSINE BASE PAIR: POSSIBLE INTERPRETATION OF THE MUTAGENIC EFFECT OF RADIATION. Robert Rein and Janos Ladik (Uppsala Univ.). J. Chem. Phys., 40: 2466-70(May 1, 1964).

The $\pi$-electronic structure of the guanine–cytosine nucleotide base pair was investigated in the semiempirical SCF–LCAO–MO approximation. An examination of the energy levels with respect to the single bases showed that the transition between the highest filled and lowest unfilled $\pi$ orbitals ($n^* \rightarrow n^* + 1$) takes place between the levels originating from two different single bases. This statement follows from considering the $n^*$ and $n^* + 1$ levels of the base pair as perturbed ones of the guanine, cytosine single bases, respectively. This view is substantiated by the structure of the eigenvectors of the respective states. The transition between these states is associated with a transfer of charge, which in the investigated case involves the transfer of a unit charge from guanine to cytosine. Since in the charge-transfer state the bases are essentially in an ionic form, a considerable increase in the probability of a single-proton tunnelling, proposed by Löwdin, may be expected. The interpretation of radioinduced mutations in terms of the charge-transfer state and single-proton tunneling is further discussed. (auth)

**21873** THE FORMATION AND PROPERTIES OF POLIOVIRUS-NEUTRALIZING ANTIBODY. II. 19S AND 7S ANTIBODY FORMATION: DIFFERENCES IN ANTIGEN DOSE REQUIREMENT FOR SUSTAINED SYNTHESIS, ANAMNESIS, AND SENSITIVITY TO X IRRADIATION. Sven-Eric Svehag and Benjamin Mandel (Public Health Research Inst. of the City of New York, Inc., New York). J. Exptl. Med., 119: 21-39(Jan. 1, 1964).

Injection of small doses of poliovirus caused the transient appearance of 19S $\gamma$-globulin antibody in rabbits after single or repeated stimuli. Cessation of 19S antibody synthesis was apparently due to lack of continuous antigenic stimulation and not to loss of cells participating in antibody formation. Immunological memory in 19S antibody formation was demonstrable only within two to three days following discontinuation of synthesis but not thereafter. Following stimulation with a high dose of poliovirus, both 19S and 7S antibodies were formed. The kinetics of their formation differed in several respects: 19S antibody preceded 7S antibody by $\sim 1\frac{1}{2}$ days; 19S antibody rose to peak titers at a rapid exponential rate within 1 week, while 7S antibody increased at a slow decelerating rate for $\sim 3$ weeks; and 19S antibody formation was short-lasting while 7S antibody synthesis endured. A renewed formation of both antibodies occurred following restimulation with a high antigen dose. The secondary 19S and 7S antibody responses were similar to the respective primary responses, and the preexistence of 7S antibody synthesis did not detectably alter the secondary 19S response. Whole-body x irradiation 20 hr prior to antigenic stimulus (high dose) resulted in delayed but markedly prolonged 19S antibody formation and inhibition of 7S antibody synthesis. Thus, antibody formation in irradiated rabbits was characterized by: a delay in 19S antibody formation of about four days (600 r) and seven days (650 r); reduction of peak 19S antibody levels to about $\frac{1}{10}$ of that in unirradiated animals; persisting 19S antibody titers; and inhibition of 7S antibody synthesis over a period of $2\frac{1}{2}$ months after antigenic stimulus. In x-irradiated rabbits 19S antibody did not, as in unirradiated rabbits, start to decline two weeks after antigenic stimulus but remained at fairly constant levels for $1\frac{1}{2}$ to 2 months. This is probably due to a reduction in number of reticuloendothelial cells engaged in antigen clearance resulting in a retention of antigen at a concentration necessary for maintained 19S formation. It is concluded that the formation of 19S and 7S antibody differs in antigen dose requirements for induction and maintained synthesis: kinetics; retention of memory; and sensitivity to prior x irradiation.

These differences are explained by the two antibodies being produced by different cells. (BBB)

**21874** RADIATION ILEITIS. Claude Bloch and Harvey M. Peck (Mt. Sinai Hospital, New York). J. Mt. Sinai Hosp., N. Y., 29: 361-4(July-Aug. 1962).

The case history of a 38-yr-old man who developed radio-induced lesions in the intestine as a result of treatment of a seminoma is reported. He was given radiotherapy to the left groin, pelvis, and para-aortic areas, but the exact dosage or details of therapy are not given. Apparently a midplane dosage of ~3500 r in five weeks was administered. The patient remained well until six months later when severe right lower quadrant pain developed. An exploratory laparotomy revealed that the ileum was congested and edematous. No radiation skin changes were noted over the abdomen or back. Barium meal examination revealed that the jejunum and proximal ileum were moderately dilated and contained increased secretions. The entire distal ileum was affected by a diffuse inflammatory process characterized by thickening and rigidity. At laparotomy, a short segment of narrowing was identified in the distal ileum, 30 cm from the ileocecal valve. There were a few areas of telangiectasia, and the strictured segment of bowel was thickened and firm. The mucosa was effaced but no discrete ulcerations were identified. Microscopically, the involved bowel revealed fibrosis and endarteritis consistent with radiation changes. An ileocolic resection was performed and the patient experienced prompt disappearance of his symptoms. A review of reported cases shows that radiation enteritis is a rare complication of x-ray therapy directed to the abdomen. Most cases reported in the literature follow pelvic radiation combined with intracavitary Ra used in the treatment of uterine carcinomas. In the usual case, a midplane dose of 5000 r or more is necessary to cause radiation damage to the intestine. This usually occurs when a single loop of intestine is adherent in the pelvis and thus receives a full cancericidal dose. Usually, when the bowel is freely movable, any one loop of bowel is not subjected to the full dose of radiation. Radiation ileitis is a rare complication of radiotherapy given in seminomas of the testis, because the dose administered to the abdomen and retroperitoneal regions is usually well below the above described level. In the current case, it is conceivable that there was a significant overlap of the borders of the various fields, thereby exposing a small volume of tissue to twice the calculated dose. The latent period is usually 5 to 16 months after cessation of therapy before symptoms of radiation enteritis occur. Patients show signs of subacute intestinal obstruction and are usually chronically ill with weight loss, secondary anemia, and hypoproteinemia. In a few cases entero-enteric or enterovesical fistulas develop. (BBB)

**21875** EYEBURN DAMAGE CALCULATION FOR AN EXOATMOSPHERIC NUCLEAR EVENT. Harris L. Mayer and Frances Richey (E. H. Plesset Associates, Inc., Santa Monica, Calif.). J. Opt. Soc. Am., 54: 678-83(May 1964).

A hazard to the eyesight of an unprotected observer may exist from the prompt visible flash caused by a high altitude or exoatmospheric nuclear event. A study was undertaken to investigate the threshold range for eyeburn damage for resident populations of Pacific Islands from the U. S. nuclear tests. In addition to a general discussion of the problem, estimates are given of the source strength in the visible from a weapon in the megaton range, the incident energy per unit area at 1000-km range, the energy absorption, temperature rise, and heat dissipation mechanisms in the retina, and the effect of ocular chromatic aberration on the reduction of energy density and therefore damage in the absorption layer of the retina was calculated. It was concluded that at most a 10°C rise in temperature, lasting for less than a millisecond, will result under the conditions assumed; this is not sufficient to cause eye damage. (auth)

**21876** EFFECT OF IRRADIATION IN INFANCY ON THE MOUSE OVARY: A QUANTITATIVE STUDY OF OOCYTE SENSITIVITY. Hannah Peters and Emilia Levy (Finsen Lab., Copenhagen). J. Reprod. Fertility, 7: 37-45(Feb. 1964).

Quantitative studies of the effect on the ovary of a single 20-r dose of x rays given at different ages early in life showed that it varies according to the age of the animal at the time of radiation. This was investigated by determining the number of oocytes surviving 24 hr after irradiation, and at varying intervals after irradiation but at a constant age of the animal (49 days). The sensitivity of the ovary depends on the response of the small oocytes as well as on the response of the growing and large oocytes. The sensitivity of these two groups differs. Further, an age-dependent variation within the two groups is noted. Fifty percent of small oocytes survive 24 hr after irradiation on the day of birth whereas irradiation after this age leaves only between 1 and 9% of these cells intact. The number of oocytes in the ovary at the time the animal enters maturity is 85% of the normal number after irradiation at birth, but only 1% after irradiation at the age of three weeks. The changing radiation sensitivity could be correlated with morphologic changes in the developing ovary. At the period of lowest sensitivity (day of birth) the small oocytes are still in transitory stages of the meiotic prophase. About half are in pachytene, are highly radiosensitive, and quickly destroyed; half are in early diplotene and unaffected by 20 r. This composition of the ovary at birth permits 50% of the total oocyte number to survive 24 hr, enough to populate the ovary with an oocyte complement, which is only slightly below normal by the time the animal enters reproductive life. High sensitivity coincides with the transformation of small oocytes to large ones, when growing oocytes are present in the largest numbers. The growing oocyte is particularly sensitive during this phase of fast transformation. The reason for the high sensitivity of the growing oocyte is not known; morphologically the nuclei in the dictyotene phase are indistinguishable from nuclei of less sensitive oocytes in later stages. (BBB)

**21877** AN IMMUNOLOGICAL METHOD OF INCREASING THE SENSITIVITY OF PRIMARY SARCOMAS TO LOCAL IRRADIATION WITH X RAYS. Alexander Haddow and Peter Alexander (Royal Cancer Hospital, London). Lancet, 1: 452-7(Feb. 29, 1964).

Experiments are reported which show that in rats the effectiveness of a single dose of 2000 r of x rays in retarding the growth of a primary fibrosarcoma can be enhanced by an autograft of the tumor, obtained by biopsy. The rationale behind this procedure is that autografting induces or augments in the autochthonous host an immune response which acts on those tumor cells that escaped destruction by the direct action of this radiation. The tumors were induced by subcutaneous implantation of benzpyrene in the rats. For autografting of the tumor fragments, the cells were rendered incapable of indefinite reproduction (i.e., rendered sterile) by exposure in vitro to 10,000 r of x rays. Immediately after the sterilizing dose of irradiation the pieces were injected back into the animal on the flank opposite to the primary tumor, and local irradiation of the tumor in the animal was carried out between 2 and 4 hr after implantation of the irradiated autograft. Irradiation

of the tumor with 2000 r caused a delay in the growth of the tumor, and the time for fourfold increase (i.e., $\sqrt[3]{4}$ times the starting diameter) was ~20 to 40 days. Introduction of an irradiated autograft raised significantly the fraction of tumors that responded exceptionally well (i.e., with a fourfolding time greater than 80 days). Autografting with irradiation-biopsy material without local irradiation did not influence the rate of growth of the tumor, and there was no significant difference in the fourfolding time of the tumors with and without an autograft. The increased radiosensitivity produced by the irradiated autograft was highly significant; autografting, however, did not produce an improved radiation response for every tumor, and a good response was limited to about half the animals. Possible causes of this variability were investigated. It was shown that only autografts are effective, and that injections of very similar tumors (or other tissue) do not sensitize, which is to be expected for an immunologic mechanism since the antigens in different tumors are not the same. It was possible to prevent the radiosensitization by large amounts of oleic acid, which are known to interfere with homograft rejection, and this also agrees with the above hypothesis. The failure of other three treatments (low doses of oleic acid, BCG vaccine, and adrenalectomy), which enhance in mice the immunologic rejection of transplants of allogenic tumors, to augment the radiosensitizing action of the autograft could not be explained, but probably the immune response of the rat cannot be boosted in the same way as can that of mice. It is concluded that the majority of primary tumors do not release sufficient antigen to provide a maximum immune response, and the effect of the irradiated autograft is to achieve more effective immunization. By itself, the irradiated autograft does not cause arrest of tumor growth, probably because the tumor is largely inaccessible to cell-bound antibodies (lymphocytes) and the magnitude of the immune response which the tumor antigens can evoke is insufficient to inactivate the large number of cells ($>10^8$) present in the tumor. Autografting, it is suggested, is able to exert an effect in conjunction with irradiation, because inflammatory processes are produced which make the tumor more accessible and the number of cells that have to be eliminated immunologically is greatly reduced. Thus 2000 r probably reduces the cells capable of indefinite replication of the original. An alternative hypothesis, that the host of the primary tumor has become tolerant to the tumor antigens and that the irradiated autograft breaks the tolerance, should also be considered. (BBB)

**21878** CHRONIC MYELOID LEUKEMIA: CYTOGENETIC STUDIES BEFORE AND AFTER SPLENIC IRRADIATION. Ishbel M. Tough, W. M. Court Brown, A. G. Baikie, Karin E. Buckton, D. G. Harnden, Patricia A. Jacobs, and Jane A. Williams (Western General Hospital, Edinburgh). Lancet, 2: 115-20(July 16, 1962).

Studies are reported for 18 previously untreated patients with chronic myeloid leukemia, particularly to determine the frequency of the abnormal, Philadelphia ($^1$Ph), chromosome which appears to be a characteristic finding in this disease. Also, the effect of irradiation on this chromosome was investigated. Cells containing the $^1$Ph chromosome were found in blood cultures in all cases except one; here, however, a direct marrow examination during an interval in treatment with busulphan showed the presence of $^1$Ph + ve cells. It is assumed that had a marrow study been possible before treatment, the characteristic chromosome would have been found. The effect of x-ray therapy to the spleen was studied in six patients. Five of these were not previously treated, while the sixth patient was treated earlier with 6-mercaptopurine. The effect of x-ray treatment on the proportion of $^1$Ph + ve cells (as found in blood cultures), and on the total white cells, is shown. Generally, the white blood count and the proportion of $^1$Ph + ve cells fell in parallel, and no $^1$Ph + ve cells were found in blood cultures when the count had fallen to about 20,000 cells/mm$^3$. The only exception was one case where the very rapid fall in the proportion of $^1$Ph + ve cells possibly was related to unusual radiosensitivity of the $^1$Ph + ve XO line of cells. This may explain why some treated cases of chronic myeloid leukemia have been reported to be $^1$Ph – ve on blood culture. The patients were all treated by two directly opposed anterior and posterior fields to the spleen; the daily surface dose was 50 rad, and the dose-rate was 67.5 rad/min. In two leukemia patients who had had previous x-ray therapy for ankylosing spondylitis a study was made of the marrow cells (in both these patients the leukemia may have been radioinduced). In a count of 150 cells from a direct marrow preparation of one case, no $^1$Ph + ve cells were found. In the other case a direct marrow preparation showed all the cells to be $^1$Ph + ve, and to have an XO constitution. It is suggested that the data support the concept that the formation of the $^1$Ph chromosome is an integral part of the leukemic process, and that it cannot be regarded as an epiphenomenon, a concomitant change of the leukemic process. It is not known whether formation of the $^1$Ph chromosome is the prime change in initiating the disease, or whether it is preceded by other changes. The study of the effects of splenic irradiation shows that, though there may be no $^1$Ph + ve cells in a blood-culture, the marrow cells, examined by a culture technique of directly, will show $^1$Ph + ve cells and usually no others. Findings may help to elucidate the mechanism of action of splenic irradiation. (BBB)

**21879** A STUDY OF THE CHROMOSOME DAMAGE PERSISTING AFTER X-RAY THERAPY FOR ANKYLOSING SPONDYLITIS. Karin E. Buckton (Western General Hospital, Edinburgh), Patricia A. Jacobs, W. M. Court Brown, and Richard Doll. Lancet, 2: 676-82(Oct. 6, 1962).

Chromosome analyses were made of leukocytes cultured from the blood of 58 patients with ankylosing spondylitis treated with x rays. The cultures were made from within a few hours up to 18 yr after radiotherapy, and in 15 cases pretreatment cultures were also made. All patients were irradiated over the whole length of the spine and sacroiliac joints with total doses of 1500 to 2500 rad, given in 10 fractions over a 2-week period. The cells, classified into three main types on the basis of chromosome abnormalities, are described. The number of polyploid cells increases considerably after irradiation. In control cultures about five polyploids were noted during analysis of 1000 cells; within a week of the completion of treatment this number had risen to about 180. Thereafter it fell, but even 5 yr later the number of polyploids was appreciably in excess of the control number. It is concluded that these results provide unequivocal evidence that extensive partial-body irradiation with medium kilovoltage x rays produces considerable chromosomal damage, some of which persists for up to 20 yr, and which may persist for the rest of the patient's life. The dividing cells appear to be altered lymphocytes; therefore the damage observed in cells from blood cultures largely reflects the effect of radiation on lymphopoietic tissues. Probably similar damage occurs in myeloid and erythrocyte precursors. It is suggested that cells with unstable and stable chromosome abnormalities can be considered as potential progenitors of a leukemic

process, on the assumption that the same sort of damage found in lymphocytes will also be found in myeloid cells. It was shown that the mortality from leukemia is increased 10-fold among patients treated with x rays for ankylosing spondylitis. For spondylitics given a single course of treatment the peak period of risk is during the 4th and 5th post-exposure years, and there may be a link between the rise and fall of the cells with unstable abnormalities, and the rise in the leukemogenic risk to its peak value. Present evidence suggests that when cells with unstable abnormalities lose chromosomal material they die out, but occasionally the loss of chromosomal material may not be lethal. Then the cell may become potentially malignant, or it and its daughter cells, by virtue of their altered genotype, may become sensitized to malignant transformation by some other agent. (BBB)

**21880** HEMATOLOGIC AND BIOCHEMICAL INDICES OF RADIATION INJURY AFTER A SINGLE EXPOSURE TO A HIGH DOSE OF IONIZING RADIATION. Josef Chojnowski and Janusz Hanke. Lekarz Wojskowy, 39: 647-54(1963). (In Polish)

A review citing 30 references is presented. (BBB)

**21881** REMARKS ON THE HAZARDS WHICH ATOMIC RADIATIONS CAN BRING TO NEUROLOGICAL CLINICS. PREVENTIVE MEASURES. A. Subias-Fages and B. Rodriguez (Instituto Neurologico Municipal, Barcelona). Med. Clin. (Barcelona), 38: 83-7(Feb. 1962). (In Spanish)

A brief review of neurologic aspects of radiation injury is presented. (BBB)

**21882** THE STATE OF THE ORGAN OF VISION IN THE ACTION OF GAMMA-NEUROGENIC RADIATION IN DOSES CLOSE TO MAXIMALLY PERMISSIBLE ONES. E. N. Lvovskaya and E. S. Kotova. Med. Radiol., 9: No. 3, 52-6(Mar. 1964). (In Russian)

Results are reported of dynamic observations conducted by ophthalmologists on a group of workers operating high-power accelerators: synchrocyclotron, accelerating protons, deuteron, and alpha particles up to energies ranging from 480 to 840 Mev; and synchrophasotron. A number of examinees worked in conditions of prevalent gamma radiation not exceeding the permissible levels, while another group worked in conditions of possible neutron irradiation. The results of ophthalmological investigations testify to the fact that 6 to 8 yr-long work under conditions of gamma-neutron radiation in doses approaching the maximally permissible ones does not cause any morbid changes in the organ of vision. (auth)

**21883** DOSE CHARACTERISTICS AND PECULIARITIES OF AFFECTION IN GAMMA-IRRADIATION OF MICE WITH DOSE INTENSITY OF 48 kr/min. L. B. Koznova. Med. Radiol., 9: No. 3, 56-61(Mar. 1964). (In Russian)

The terminal portion of the dose curve for mice (doses ranging from 10 to 135 kr) was studied during the use of $^{60}$Co gamma irradiation of great dose intensity—48 kr/min. Emphasis is placed on the great importance of individual peculiarities of the organism in conditions of the experiment, as action of radiation with a dose intensity of 48 kr/min in comparison with 0.387 to 2 kr/min. This fact broadens the range of dose intensities during which a reduction of the biological effect becomes manifest. (auth)

**21884** HISTOCHEMICAL CHANGES OF LEUKOCYTES IN EXPERIMENTAL RADIATION SICKNESS. V. A. Almazov, T. L. Rogova, and E. A. Ruppe (Pavlov Medical Inst., Leningrad). Med. Radiol., 9: No. 3, 61-6(Mar. 1964). (In Russian)

Morphological and cytochemical changes of granulocytopoiesis and leukocytes of the peripheral blood in rabbits with experimentally induced radiation sickness were assessed. It was found that in rabbits following irradiation, along with cytopenia in the blood and hypoplasia in the bone marrow, there occurs a considerable decrease of nucleic acid concentration, oxidation enzymes, and glycogen. A diminished content of glycogen in neutrophils is usually preceded by its short-term rise (maximally six hr after irradiation). Changes of metabolic activity of neutrophils, along with their reduced content, are decisive factors in the development of septicemia in radiation sickness. (auth)

**21885** PARAMETERS AND WAYS OF ASSESSING BIOLOGICAL EFFECTS OF ULTRAFRACTIONATED RADIATION. A. A. Skuratovich. Med. Radiol., 9: No. 3, 79-80(Mar. 1964). (In Russian)

A review is given of published data on experimental-biological studies of ultrafractionated radiation. Biophysical, oncological, and dosimetric aspects of ultrafractionated radiation are discussed, and it is suggested that further studies are required to determine the mechanism of ultrafractionated radiation effects. (R.V.J.)

**21886** PROCTOSIGMOIDITIS RESULTING FROM TELECOBALT RADIOTHERAPY. C. Arullani, R. C. Basile, and V. U. Adami (Ospedali Riuniti, Rome). Minerva Gastroenterol., 7: 158-62(Oct.-Dec. 1961). (In Italian)

Injury to the large intestine caused by $\gamma$ radiation in humans is described. (BBB)

**21887** GENETIC EFFECTS. Henry Quastler (Brookhaven National Lab., Upton, N. Y.). N. Y. State J. Med., 64: 861-3(Apr. 1, 1964).

A general discussion of the mutagenic effects of ionizing radiation is provided, and by comparison the occurrence of other mutagens in the human environment is considered. The mechanism of genetic changes, with alterations induced in DNA and RNA, is briefly reviewed. It is concluded that radiation does exert genetic effects and that some of these genetic effects are extremely insidious. On the other hand, radiation is only one out of many agents which affect genetic material. (BBB)

**21888** EFFECTS OF SINGLE AND FRACTIONATED DOSES OF TOTAL BODY X-IRRADIATION IN UTERO ON GROWTH OF THE BRAIN AND ITS PARTS. K. R. Brizzee (Univ. of Nebraska, Lincoln). Nature, 202: 262-4(Apr. 18, 1964).

Pregnant Sprague-Dawley rats were exposed on the 15th day of gestation either to a single 150 rad dose of x rays or to five equal x-ray exposures of 30 rads each over a 12 hr period. At 1, 5, 10, 20, 50, and 100 days after birth, animals from each group were anesthetized; body weight was determined; and brains were examined. Fractionation resulted in marked alterations in the growth of major subdivisions of the brain. Equivalent changes were noted in the single-dose group. The greatest effect of the pre-natal irradiation in this investigation was exerted on the prosencephalon. (H.M.G.)

**21889** SYNTHESIS OF DEOXYRIBONUCLEIC ACID IN X-IRRADIATED BACTERIA TREATED WITH CHLORAMPHENICOL. B. Miletic, Z. Kucan, and Lj. Sasel (Institute "Ruder Boskovic," Zagreb). Nature, 202: 311-12 (Apr. 18, 1964).

Escherichia coli B. grown in mineral media were irradiated during the log phase of growth. Chloramphenicol was added at the final concentration of 10 $\mu$g/ml. It was found that DNA synthesis in irradiated bacteria and in irradiated

bacteria treated with chloramphenicol led to an extensive enhancement of DNA degradation and to a prolongation of the degenerative process, or possibly to a resynthesis of DNA in bacteria given 4, 6, and 8 kr doses. (H.M.G.)

**21890** INHIBITION OF THE GROWTH OF IMPLANTED MOUSE CARCINOMA BY AN IRRADIATED BACTERIAL CULTURE. Arthur Compton (St. Mary's Hospital, London). Nature, 202: 404(Apr. 25, 1964).

Techniques introduced by C. A. Pannett for inhibiting carcinoma growth are discussed in relation to previous work done by Arthur Compton. Using x-irradiated E. coli culture medium as the inhibitor, variant points of the Pannett procedure were: initially smaller tumor grafts; 48 hour broth cultures for the irradiation; larger irradiation dosage (150,000 r); oxoid culture medium; and subcutaneous injection of irradiated culture medium free of bacteria either before or after irradiation. (H.M.G.)

**21891** INFLUENCE OF ULTRASOUND ON BONE MINERAL METABOLISM. Jaromír Kolář, Arnošt Babický, Jiřina Káclová, and Jaromír Kácl (Charles Univ., Prague). Nature, 202: 411-12(Apr. 25, 1964).

Ultrasonic pulses produced by a magnetostrictive dental unit were transmitted into two groups of white male Wistar rats. In one group, the knee area of the right hind limb was pulses for 5 min daily for 102 days. In the second group of animals the necks of both incisors in the mandible were irradiated for 2 min daily for 84 days. At intervals of 4, 8, 16, 21, 28, 42, 62, 84, and 102 days animals separated from each group, including a control group, were given 20 $\mu$C doses of $^{45}CaCl_2$ intraperitoneally. Following ultrasonic treatment of the hind limb, a reduced $^{45}Ca$ uptake was seen in both the treated and the opposite tibial bones, and a slight depression in uptake by the shoulder blades and incisors was noted. In animals with ultrasonically pulsed teeth, uptake differences could be found in the incisors and in the tibia. (H.M.G.)

**21892** CHANGES IN THE RADIATION SENSITIVITY OF MICE AFTER TEMPORARY RESIDENCE IN HYPOXIA. Bernhard Tribukait and Arne Forssberg (Karolinska Institutet, Stockholm). Naturwissenschaften, 51: 12-13 (1964). (In German)

The effects of radiation on mice after a temporary oxygen deficiency were studied. After 10 days in a chamber with an oxygen deficiency, part of the mice were kept as controls, along with others not subjected to oxygen deficiency, and the others were irradiated with x rays at 250 kv. Mice not subjected to oxygen deficiency were also irradiated. The total dose amounted to 756 r. Survival times of the mice are shown in graph form. The animals pretreated by hypoxia and irradiated showed a decrease in radiation sensitivity. (M.C.G.)

**21893** FIXATION OF AMMONIA NITROGEN BY THE RUMEN LINING IN VITRO BY X IRRADIATION. Johannes Brueggemann and Dieter Giesecke (Universität, Munich). Naturwissenschaften, 51: 17-18(1964). (In German)

The most important work of the rumen lining is protein synthesis from ammonia nitrogen. The influence of x radiation on this ammonia fixation was studied. With increasing dose rates the rate of ammonia decrease in the rumen decreased. Therefore, there was a decrease in nitrogen fixation and in protein synthesis. (M.C.G.)

**21894** THE RELATIVE BIOLOGICAL EFFECTIVENESS OF 200 kvp X-RAYS, $^{137}Cs$ $\gamma$-RAYS, $^{60}Co$ $\gamma$ RAY AND 22 Mev X-RAYS ON THE THREE TYPES OF TISSUE CULTURED HUMAN CELLS. Shosuke Yoshimura and Takahiro Kozuka (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1073-9(Dec. 1963). (In Japanese)

Cells were exposed to radiation doses of 200, 400, and 600 rads in the acrylite phantom. The RBE was determined for mitotic rate measured by cell population on the 8th day following irradiation. Results revealed that cells given the same dose were more sensitive to 200-kvp x rays than the other three types of irradiations. Relative to x rays, the RBE values of $^{137}Cs$ $\gamma$ rays, $^{60}Co$ $\gamma$ rays and 22-Mev x rays were 0.99 ~ 0.90 at the dose of 200 ~ 600 rads, which values were found to be proportional to LET. As for $\gamma$ rays, RBE decreased with increasing dose in the range of graded doses 200 to 600 rads. No dose rate dependence of RBE was found for $\gamma$-ray and x-ray irradiation from 18 rads/min to 90 rads/min. The radiation sensitivity of the cells derived from normal human tissues was slightly higher than that of HeLa cells. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**21895** ENDOMETRIAL CANCER IN PATIENTS PREVIOUSLY IRRADIATED FOR CERVICAL CANCER. Dan C. Mills (Washington Univ., St. Louis). Obstet. Gynecol., 22: 280-5(Sept. 1963).

Attempts were made, by a survey of 61,051 specimens of pathologic tissue collected from 1935 to 1961, to evaluate the occurrence of cancer of the uterine endometrium as a sequel to radiotherapy for cervical cancer. The occurrence of such endometrial lesions in previously irradiated patients poses the question of carcinogenic effects of ionizing radiations. Of the 61,051 specimens, 3181 were diagnosed primarily as squamous cell carcinoma of the cervix, 852 as adenocarcinoma of the endometrium, and 8 as sarcoma. There were three additional specimens with the diagnosis of concurrent squamous cell cancer of the cervix and adenocarcinoma of the endometrium. A review of the pathologic records pertaining to the 3181 cases of cervical cancer showed a later diagnosis of endometrial cancer in two instances. Among the 852 specimens diagnosed as adenocarcinoma of the endometrium there was an earlier diagnosis of squamous cell cancer of the cervix in three instances. Assessment of the incidence of endometrial cancer following irradiation for cervical cancer was made using other data. In another analysis of patients treated during the 1914-1941 period six examples were found among 4396 patients, or 0.13%. A third survey reported a much higher incidence: three examples in 471 patients, or 0.64%. It is apparent that double primary cancers of endometrial and cervical varieties are less frequent than many other combinations. Thus, in 194 examples of double primary lesions in 2829 cases of cancer of all types, the incidence was 6.8%. That ionizing radiation may produce cancer of the endometrium has not yet been confirmed, and it is concluded that the present data are inadequate for additional exploration of the carcinogenic effects of radiation. If the incidence assessment made here, suggesting a rate of ~ one per 1000, is supported in later statistics, and if it is correlated with life tables showing the expected rate of incidence for endometrial cancer in specific age groups, it may then be possible to evaluate more accurately the effects of radiation. It is concluded that it is not yet possible to assess the carcinogenic effects on the endometrium of ionizing radiations applied in the treatment of primary cervical cancer. (BBB)

**21896** RADIATION CARCINOGENESIS. W. M. Court Brown (Western General Hospital, Edinburgh). Practitioner, 190: 715-19(June 1963).

This historical survey shows that the first report of a tumor which was probably induced by radiation exposure

(a squamous carcinoma of the hand of a worker in a factory for the production of x-ray tubes) appeared in 1902. Since then many instances of radioinduced tumors have appeared, of two general classes: those developing in patients and considered to be related to previous exposure, almost invariably therapeutic, and those occurring among persons occupationally exposed to radiations. (BBB)

**21897** PROBLEM OF RBE IN RADIOBIOLOGICAL RESEARCH IN SPACE MEDICINE. E. H. Graul (Phillips-Universität, Marburg, Ger.). Raumfahrtforschung, 8: 1-9(Jan.-Mar. 1964). (In German)

The effect of ionizing radiation on living tissue depends not only on the amount of energy absorbed, but also on a number of other factors, e.g., differential distribution in the ionization pattern and concentration of $O_2$ in the tissue. In contrast to "r," "rep" or "rad," the value "rem" (roentgen equivalent man) has taken the character of a biological dose value determined by two factors: the amount of energy absorbed in "rad" and the RBW (relative biological effectiveness). The radiobiological significance of RBE research and of "rem" is discussed in regard to the effect of highly accelerated nuclei, especially the heavy primary particles. It was concluded that in the radiobiology of space travel the concept of "rem" becomes problematical or even irrelevant in the case of thin-down hits from these heavy primaries. (auth)

**21898** PRELIMINARY STUDIES ON THE EXCRETION OF 4-HYDROXY-3-METHOXY-MANDELIC ACID AFTER X-RAY IRRADIATION. G. Libotte, A. Dresse, H. Ramioul, R. Zutterman, and J. Lecomte (Université, Liege). Rev. Belge Pathol. Med. Exptl., 29: 294-7(Jan. 1963). (In French)

Vanillyl mandelic acid (VMA) or 4-hydroxy-3-methoxy-mandelic acid is the end product of epinephrine and norepinephrine metabolism and is eliminated in the urine. Determination of urinary excretion of this acid was used to study the function of the sympathetic nervous system and that of the adrenal medulla following irradiation, in patients suffering from metastatic mammary tumors. Repeated x-ray doses of 50 to 70 r, distributed over six weeks and totaling 1000 r, applied to the lumbar region on both sides of four patients, did not affect the urinary elimination of VMA, either during or following radiation treatment. Irradiation of the same regions with higher total doses, 5000 to 6000 r to each side (200- to 300-r individual doses over the same time period), also did not affect VMA excretion. Nor did comparable doses applied to other anatomic regions produce any statistically significant variation in excreted VMA levels. It was concluded that irradiation at these doses has no effect on urinary elimination of VMA or on sympathetic nervous system function. The persistence of VMA excretion after radioadrenalectomy does not elucidate the effects of this procedure. It is known that even after surgical removal of the adrenal VMA excretion may remain at normal levels because of compensatory hyperfunction of the postganglionic sympathetic fibers. (BBB)

**21899** SIX ATTEMPTED RENAL HOMOTRANSPLANTATIONS IN HUMANS AFTER IRRADIATION OF THE RECIPIENT. J. Hamburger, J. Vaysse, J. Crosnier, J. Auvert, C. M. Lalanne, and J. Dormont (Hôpital Necker, Paris). Rev. Franc. Etudes Clin. Biol., 7: 20-39(Jan. 1962). (In French)

The use of whole-body irradiation to reduce immunologic reactions and prevent graft rejection is described. (BBB)

**21900** STUDIES OF THE MUTAGENIC EFFECT OF COSMIC RADIATION. J. Eugster. Therap. Umschau, 20: 237(May 1963). (In German)

The reported observations were made on male and female human subjects at a height of 3500 m. The method of study consisted of a comparison of localization of physical events produced by cosmic radiation with pathologic cell changes that occurred in precancerous skin. As the result of a study of over 800 serial sections it was apparent that the areas of most frequent cosmic radiation hits are associated with evidence of cell changes. In certain skin areas, retrogressive mutations are observed. These areas coincide with the center of extensive masses of precancerous tissues that are in the first stages of incipient malignancy. These are correlated with the greatest density of ionization centers. On the basis of this observation it can be concluded that such retrogressive mutations are probably much more frequent during the processes of incipient cancer than has been previously supposed. (BBB)

**21901** CHANGES IN THE EFFECT OF DRUGS IN IRRADIATED ANIMALS. M. C. Hsieh. Yao Hsueh Hsueh Pao, 9: 393-701(Nov. 1962). (In Chinese)

A review with 55 references is presented. (BBB)

**21902** HIGH-ENERGY RADIATIONS. Carl C. Clark (Martin Co., Baltimore). p.47-99 of "Physiological Problems in Space Exploration." Springfield, Ill., Charles C. Thomas, Publisher, 1964.

Problems of measurement and terminology; the physical characteristics of the various types of high-energy radiations; the energy spectra, component radiation and time variations of the natural and man-made radiation sources of concern to a space traveler; the biological effects due to these radiations; and means of protection are reviewed. The material presented is but a brief introduction to large fields of study which are developing rapidly, with still limited human experience. With only eighteen days of total human experience above an altitude of 30 km (as of September, 1963), most views of space radiation problems are estimates from preliminary space physical measurements and from ground biological exposure experiments. Cosmic particle energies to $10^{19}$ have been measured. The most powerful terrestrial particle accelerators still attain only $10^{10}$ ev. However, the preliminary data do establish that high energy radiations are of major significance to manned space exploration. Solar cosmic storms pose a threat of possible catastrophe similar to ocean storms for the early terrestrial explorers, although of less probability. (auth)

**21903** THE INFLUENCE OF ENVIRONMENTAL FACTORS ON THE MICROBICIDAL EFFECT OF IONIZING RADIATION. B. A. Bridges (Univ. of Reading, Eng.). Thesis, Reading, Eng., Univ. of Reading, 1961.

**21904** RADIATION INJURY AND SOMATIC MUTATION. REPORT OF SYMPOSIUM HELD AUGUST 11 TO 12, 1962. Gamma Field Symposia, No. 1. Ohmiya-machi, Ibaraki-ken, Japan, Institute of Radiation Breeding, 1962. 83p.

Eight papers were presented, and separate abstracts were prepared for each. (H.M.G.)

*For abstracts of individual papers see: 21905, 21906, 21907, 21908, 21909, 21910, 21923, and 21924.*

**21905** A NOTE ON BIOPHYSICAL ASPECTS OF RADIATION BIOLOGY. Sohei Kondo (National Inst. of Genetics, Misima, Japan). p.1-8 of "Radiation Injury and Somatic Mutation." Ohmiya-machi, Ibaraki-ken, Japan, Inst. of Radiation Breeding, 1962.

The fact that 1 kr of x rays, which corresponds to a temperature increase of the order of only $10^{-3}$°C, produces biological damage means that the structure primarily injured must be an organized integrity with a considerable area. The chromosome thread satisfies the required conditions for such an essential structure of cells. Cellular function is governed by a set of numerous genes located linearly along chromosomes of each cell and cases are known where the deficiency of only a few genes, a minor part of chromosomes, upsets normal cellular function or results in cellular death. The RBE-LET relation also supports the view that primary lesions of radiation damage are chromosomal ones. Moreover, chromosomes are very sensitive to radiation because of their complex structure. These two factors are responsible for the high radiation sensitivity of living things. (auth)

**21906** THE RELATION BETWEEN RADIOSENSITIVITY AND THE DEVELOPMENTAL STAGE IN RICE. Takeshi Kawai (National Inst. of Agricultural Sciences M.A.F., Hiratsuka, Japan). p.31-42 of "Radiation Injury and Somatic Mutation." Ohmiya-machi, Ibaraki-ken, Japan, Inst. of Radiation Breeding, 1962.

There are marked differential responses of rice plants to radiation due to the developmental stages. Such differential responses are observed even on the rate and spectrum of chlorophyll mutations. The pattern of differentiation of germinal tissue can be clarified by the above type of studies. The semi-acute gamma irradiation gives a larger number of mutations than the acute x ray irradiation of the unicellular embryo when radioinduced lethality is taken into account. According to the experimental results of Nybom et al., the maximum frequency of $\gamma_3$ spikes with chlorophyll mutations after chronic irradiation of barley throughout its entire growth stage was 5.3%. Results show that the maximum number of mutations per 100 $\gamma_3$ strains after semi-acute gamma irradiation of rice plant at the post-meiotic stage is larger than the number of mutations per 100 $R_1$ ears usually obtained after seed irradiation. (auth)

**21907** THE EFFECT OF RADIATION ON TULIP BREEDING. Mitsuya Nezu (Toyama Agricultural Experiment Station, Toyama-ken, Japan). p.43-9 of "Radiation Injury and Somatic Mutation." Ohmiya-machi, Ibaraki-ken, Japan, Inst. of Radiation Breeding, 1962.

Tulip bulbs irradiation with $^{60}Co$ $\gamma$ rays produced petals with color spots during the first season. Mutants in flower color were detected in one variety for five successive years. Other mutants obtained were: variegated leaves, white-edged and striped forms, and a dwarf mutant. The relation between color spot size and bulb life cycle is discussed. It is suggested that the direct cause of bud mutation is a somatic mutation of epidermal or initial cells that subsequently divided and mixed with normal cells. (H.M.G.)

**21908** MUTATIONS INDUCED BY RADIATION IN VEGETATIVELY PROPAGATED PLANTS WITH SPECIAL REFERENCE TO FLOWER COLOR. Taro Fujii (National Inst. of Genetics, Misima, Japan). p.51-60 of "Radiation Injury and Somatic Mutation." Ohmiya-machi, Ibaraki-ken, Japan, Inst. of Radiation Breeding, 1962.

Bud mutation induced by radiation can be used to obtain new colors in ornamental plant breeding. The change of flower color in flowering plants was obtained by radiation at a relatively high frequency as the result of a relatively simple biochemical process. The occurrence of mutation is sometimes accompanied by low viability or high sterility which is an obstacle to mutation breeding. Therefore, mutations of major genes are often useless for crop plant breeding. But when propagation from vegetative organs is practiced, high sterility is no obstacle in breeding. Thus, irradiation of shoots, tubers and bulbs represents a useful method for the breeding of a vegetatively propagated plant. (auth)

**21909** GUIDE TO THE INSTITUTE OF RADIATION BREEDING. Kiyoshi Kawara (Inst. of Radiation Breeding, Ohiya-machi, Ibaraki-ken, Japan). p.61-6 of "Radiation Injury and Somatic Mutation." Ohmiya-machi, Ibaraki-ken, Japan, Inst. of Radiation Breeding, 1962.

Design of a gamma radiation field for chronic irradiation studies is discussed. Dose rate and scattering factors are considered. (H.M.G.)

**21910** RESULTS OF STUDIES AT THE INSTITUTE OF RADIATION BREEDING UP TO THE PRESENT. Sachihiko Tanaka (Inst. of Radiation Breeding, Ohmiya-machi, Ibaraki-ken, Japan). p.67-73 of "Radiation Injury and Somatic Mutation." Ohmiya-machi, Ibaraki-ken, Japan, Inst. of Radiation Breeding, 1962.

In order to study the genetic responses of plants to chronic exposures of ionizing radiation and their practical application to plant breeding, the Institute of Radiation Breeding was established on April 16, 1960. The first irradiation test was attempted in June 1961, and since April 1962, irradiation has been regularly conducted. The radiation is obtained from a point source with approximately 2,000 C of $^{60}Co$ that is built into the irradiation device kept on the irradiation tower. In the chronic irradiation, at present, it is still not possible to estimate the radiosensitivity of different varieties, species, and genera; therefore, information is being gathered on various aspects of radiosensitivity of growing plants under chronic exposures. The sensitivity will depend on the doses that cause transient physiological damages and death to the irradiated plants. In the handling of breeding materials, the procedure will be different depending on the plant-propagating methods. In the case of seed-propagated plants, the progenies of the seeds will be raised for mutation study, and in vegetatively propagated plants, the buds and shoots that have been exposed to irradiation may be propagated by cutting or grafting in order to obtain mutants, and their heritable nature, characteristics, and mutation rates will be examined. At present, crop plants, vegetables, forage plants, forest trees, fruit trees, mulberry trees, tea plants, and flower plants are planted in the gamma field. Investigations have begun on the changes in the population of the soil microorganisms and nematodes within the gamma field and the succession of vegetation around the field. At present, various plants are being irradiated in this gamma field for genetic researches as well as for practical breeding studies. (H.M.G.)

**21911** RESULTS OF LABORATORY AND FIELD TEST ON GAS-PLASMA IRRADIATED COTTONSEED. J. C. Webb, R. B. Stone, Jr., and J. B. Pate (Univ. of Tennessee, Knoxville). 15p. (CONF-158-2)

From American Society of Agricultural Engineers 1963 Annual Meeting, Miami Beach, Fla., June 1963.

In the germination tests, there was significant increase in early germination in all three seed types and a significant increase in radicle development in the fuzzy and machine-delinted seed. The results from three years of field tests with one electrical treatment indicated that there was no benefit from this glow discharge seed treatment. Germinator tests are being conducted on other treatments and those

treatments showing promise in the germinator will be further tested in the field. (auth)

## Radiation Effects Therapy and Countermeasures

**21912** THE DEVELOPMENT OF LEUKEMIA IN LETHALLY IRRADIATED MICE PROTECTED WITH CELLS FROM MICE OF A HIGH INCIDENCE LEUKEMIA STRAIN. Esther Fincher Hays and Edward M. White (Univ. of California, Los Angeles). Blood, 23: 557-63(May 1964).

Experiments in a low-leukemia-incidence strain of mice show that certain cells from a high-leukemia-incidence strain (AKR) have a leukemic potential that can develop even when they reside in a foreign host. The results indicate that these cells are most prevalent in the 20-week-old AKR thymus, but are also found to be present in AKR bone marrow as early as 7 weeks of age. (auth)

**21913** PROTECTIVE EFFECTS OF A RADIOPROTECTIVE AGENT ON TESTES INJURY OF PRENATALLY X-IRRADIATED RATS. Benjamin H. Ershoff and Gurwant S. Bajwa (Western Biological Labs., Culver City, Calif.). Exptl. Med. Surg., 21: 101-7(1963).

Data are presented indicating that a radioprotective agent administered immediately prior to x irradiation on the 18th day of pregnancy in the rat largely counteracted the adverse effects of such radiation on the subsequent weight and microscopic appearance of the testes in the young. Eighty Long-Evans rats were subjected to a single exposure of 150 r total-body x irradiation on the 18th day of pregnancy. Groups I and V served as noninjected controls; groups II and VI were given an intraperitoneal injection of pH 7.5 phosphate buffer solution; and groups III and VII and IV and VIII received a single intraperitoneal injection of 2-mercaptoethylguanidine (MEG) as a 3% solution at levels of 100 and 150 mg MEG respectively per kg body weight (injected 20 min prior to x irradiation). Only groups V-VIII were irradiated. No significant differences in body weight or gross appearance of the young at birth or at 5, 10, or 21 days of age were observed between the various groups, nor did these groups differ in respect to the percentage of young that survived at 21 days of age. When examined at the age of 72 days, the offspring of noninjected rats exposed to 150 r (group V) exhibited a marked reduction in testes weight and aspermatogenesis due to degenerative changes in the germinal epithelium compared to the testes weight and normal appearing seminiferous tubules in the offspring of noninjected, nonirradiated controls. Similar changes were observed in the offspring of buffer-injected, irradiated rats (group VI). These effects were largely counteracted by MEG at a level of 150 mg/kg of body weight (group VIII). A similar but less marked protective effect was observed in the offspring of rats in group VII. No significant differences in body and testes weight and the microscopic appearance of testes were observed in the offspring of nonirradiated rats (groups I-IV). MEG when administered at these dosage levels did not reduce the high incidence of anophthalmia and microphthalmia in the young of rats exposed to a single dose of 150 r total-body x irradiation on the 10th day of pregnancy or the increased caries susceptibility. Preliminary studies indicated that cysteamine, when injected intraperitoneally at a level of 100 mg/kg body weight 20 min before exposure to 150 r total-body x irradiation on the 18th day of pregnancy in the rat, had activity on the testis comparable to that of MEG. (BBB)

**21914** INTERMOLECULAR REACTIONS BETWEEN GLYCEROL AND LACTATE DEHYDROGENASE. INFLUENCE ON THE RADIATION SENSITIVITY OF THE ENZYME. W. Lohmann, A. J. Moss, Jr., and W. H. Perkins (Univ. of Arkansas Medical Center, Little Rock and Veterans Administration Research Support Center, Little Rock, Ark.). J. Nucl. Med., 5: 304-6(Apr. 1964).

The change in radiosensitivity of lactate dehydrogenase by glycerol was investigated spectrophotometrically. The irradiation doses varied between 0 and $4.5 \times 10^5$ r. Small amounts of glycerol (0.0005 vol %) gave a maximum protective effect. This protective effect can be explained by a complex formation between glycerol and the metal ions present in the enzyme molecule. (auth)

**21915** COMPARISON OF THE EFFECTS OF AUTOLOGOUS VERSUS HOMOLOGOUS MARROW INFUSION IN THE IRRADIATED DOG. William E. Trumbull, Iwao G. Kawakami, and Jack A. Cannon (Univ. of California, Los Angeles). J. Surg. Res., 4: 7-11(Jan. 1964).

The purpose of this investigation was to compare the effect of homologous marrow infusion with that of autologous marrow infusion on the survival of sublethally and lethally irradiated mongrel dogs, that is, genetically unrelated pairs. Although similar work has been done on the effects of radiation on rats, it was of interest to test in a larger animal the effects of autotransplantation and homotransplantation on the length of survival of the lethally irradiated animals. The first group of dogs were preirradiated with 250 and 500 r. Of five dogs that received the lowest level of radiation, 250 r, four survived. After the 500-r x-ray dose, infusion of autologous marrow prolonged survival over that of untreated controls. There were four survivors (23.5%) out of 17 dogs in the autografted group, whereas there were no survivors in the 9 control animals. The mean length of survival in the group infused with marrow was 28.7 vs 9.3 days in the noninfused controls. The amount of marrow infused varied from $1.3 \times 10^8$ to $2.65 \times 10^9$ nucleated cells. The infused marrow led to a continuous increase of the leukocyte count after an initial drop during the second to sixth days after irradiation. The control dogs, all of which expired, did not show any rise in the white blood cell count after the first day after irradiation. Since the technique of autografting marrow at the $LD_{100}$ level of irradiation was satisfactory for reimplanting viable marrow cells and obtaining permanent survivors, similar experiments were then conducted to evaluate the ability of this method to obtain permanent survivors in homografted dogs. When 5 dogs were irradiated with 250 r, there was one survivor. The mean survival time among all the dogs was 29.2 days and among those that expired it was 14.0 days. The lone survivor was subjected to a skin homograft from its marrow donor, but it sloughed at 14 days. All three dogs irradiated at 350 r and two dogs irradiated at 400 r, and subsequently homografted with marrow, expired. The mean survival time for 350 r was 12.6 days and for 400 r, 10.4 days. After 250 r the mean leukocyte counts initially rose on the first three days, then fell rapidly to between 2000 and 3000 cells/$mm^3$. In the 350- and 400-r recipient animals the leukocyte counts initially rose for the first two days, then dropped to levels below 1000 cells/$mm^3$ until death. A reasonably high percentage of survivors was seen in those irradiated at $LD_{50}$ (250 r) whereas a much smaller number of survivors was found in the group irradiated at $LD_{100}$ (500 r). Irradiation in the $LD_{50}$ group probably resulted in incomplete suppression of bone marrow function so that survivors were maintained on the cumulative marrow function of the autologous mar-

row that had been infused, plus residual long bone marrow that had escaped the effects of radiation. The techniques used failed to repopulate the depleted marrow effectively enough to protect the recipient from the acute radiation syndrome from the $LD_{100}$ range. From the one survivor obtained with the dose of $LD_{50}$ plus homologous marrow, it is apparent that survival was dependent upon residual marrow that had survived irradiation. It is concluded that genetic differences have considerable significance in whether or not survivals of marrow homografts take place. When a close relation exists between donor and recipient, the best results are achieved, whereas nonrelated animals, such as were used in this experiment, give poor overall survival results. (BBB)

**21916** PRESENT KNOWLEDGE OF SURGICAL TREATMENT OF SEVERE RADIATION BURNS. T. S. Mikhov. Khirugiya (Sofia), 15: 817-20(1962). (In Bulgarian)

Plastic surgical techniques for repairing radiation injuries are discussed. (BBB)

**21917** ANALYSIS OF THE MECHANISM OF ACTION OF ANTIRADIATION AGENTS IN THEIR PRACTICAL EMPLOYMENT, THE PROTECTIVE ACTION OF PREPARATIONS IN ADMINISTRATION INTO THE RECTUM. S. P. Yarmonenko and G. F. Palyga (Inst. of Health Physics, Moscow). Med. Radiol., 9: No. 3, 66-70(Mar. 1964). (In Russian)

Under study was the influence of radioprotective preparations on the survival of albino mice in per-rectal administration 30 min before whole-body gamma irradiation ($^{60}$Co) in a dose of 900 rad (LD-100/30). In this route of administration 5-methoxytryptamine proved to be the most effective, yielding 85% survival of mice in a dose of 75 mg/kg. 2-Mercaptoethylamine produced a lesser protective effect. 2-Aminoethylisothiuronium produced a protective effect only when used in large doses (600 mg/kg; survival–53% of animals) which caused a 25% death of animals due to the toxic effect soon after the administration. In intraperitoneal injection (150 mg/kg) or peroral administration of AET (300 mg/kg) increased the survival rate up to 90 to 100%. A supposition is set forth on the possible employment of preparations for the purpose of local protection of the rectal mucous membrane in radium therapy of pelvic organs. (auth)

**21918** EFFECTS OF 5 METHOXYTRYPTAMINE ON THE SKIN CHANGES INDUCED BY IONIZING RADIATION IN RATS AND MICE. M. B. Turgunov, Yu. D. Sorokina, and V. S. Turusov (Inst. of Experimental and Clinical Oncology, Academy of Sciences, USSR). Med. Radiol., 9: No. 3, 70-4(Mar. 1964). (In Russian)

The protective effects of intraperitoneally injected 5-methoxytryptamine against whole-body x irradiation were studied with 59 newborn black mice weighing 3.5 g each. The protective effects against large $\beta$ radiation doses were studied using 18 white male rats weighing 160 to 220 g. A progressive falling out of hair was observed in 4 to 5 days following whole-body exposure of unprotected mice with total baldness at 7 to 13 days. Twenty-two days later the hair began to grow with complete restoration of stiffer and partially gray hair. The protected mice suffered only a slight baldness on the head and shoulders. However, various changes were observed in the epithelial cells at various dates. A month later histological studies exhibited a larger number of hair follicles with a great deal of mitosis in the hair bulb of both groups. The local $\beta$ exposure resulted in local hair fallout with skin ulcerations. A partial or complete epithelium was observed up to 30 days after exposure, followed by partial restoration of fur. In rats treated with 5-methoxytryptamine the growth of hair was inhibited with fallout of hair 5 to 7 days following the exposure with total epilation of the exposed part on the 18th day. A complete restoration of fur took place after 60 days. It was established that 5 methoxytryptamine protects the epithelium part of the hair follicles in whole-body x-ray exposure and the connective tissue in local $\beta$ irradiation. (R.V.J.)

**21919** NEW FINDINGS ON EXPERIMENTAL RADIOBIOLOGY ON TUMORS. J. S. Abbatucci, J. Jacquet, and P. Jacob (Université, Caen, France). Rev. Pathol. Gen. Physiol. Clin., 63: 467-80(Apr. 1963). (In French)

From this review, three recent contributions to understanding of the radiosensitivity of tumors stand out: the introduction of more precise quantitative methods for determining cellular radiation susceptibility; demonstration of the importance of immunologic phenomena; and the radioresponse of tumor tissue is increased two to three times by the presence of $O_2$ over that under conditions of anoxia. The possibility of finding chemical compounds with the property of preventing the inactivation of radioinduced free radicals in tumor tissue is discussed. The use of certain chemotherapeutic agents to synergize radiation effects is also considered, and their mode of action is discussed. Among the most efficient of these, for use in conjunction with radiotherapy, are: 5-fluorouracil, actinomycin, bromo- and iododeoxy-uridines. (BBB)

**21920** PROCEDURES FOR SAVING VICTIMS OF ATOMIC WEAPONS. Nelson de Figueiredo (Escola do Serviço de Saúde Militar, Lisbon). Rev. Port. Med. Militar, 8: 115-38(1960). (In Portuguese)

**21921** STUDIES ON EXPERIMENTAL LEUKEMIA INDUCED BY X-RAYS, ESPECIALLY THE ANTI-LEUKEMIC EFFECT OF ACTH. Kiyoshi Hiraki and Ichiro Iwasaki (Okayama Univ., Japan). Sogo Rinsho, 12: 1219-27(June 1963). (In Japanese)

Two types of lymphatic leukemia, the thymomatous type and the nonthymomatous, are induced in 30- to 40-day-old RF strain mice by a single whole-body irradiation (33.5 r/min for a total dose of 350 r). The former was characterized by tumorous hypertrophy of the thymus, slight anemia, and leukocytosis, and the latter by severe anemia, leukocytosis, and hypertrophy of the spleen and lymphatic, but change of the thymus was hardly seen. Leukemia occurred in 45 of 51 animals, and no difference was recognized between the sexes. Subcutaneous and intraperitoneal transplantation of leukemic spleen and lymphatic node into normal mice produced leukemia and led to deaths 52 days after in the thymomatous type and 30 days after in the nonthymomatous type. Of 13 mice receiving the same dose and injected with ACTH (0.1 mg/g) subcutaneously, only five contracted leukemia. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21922** VAGINAL RECONSTRUCTION FOLLOWING PELVIC EXENTERATION FOR CANCER OF POSTIRRADIATION NECROSIS. John T. West (National Cancer Inst., Bethesda, Md.), Alfred S. Ketcham, and Robert R. Smith. Surg. Gynecol. Obstet., 118: 788-94(Apr. 1964).

Obliteration of the vagina may be a consequence of attempts to cure advanced cancer of the pelvis, and the ischemia, fibrosis, and other changes in the perineum following extensive irradiation and surgery act as deterrents in attempts at reconstructive procedures. Performance of vaginal reconstruction in 12 women and subsequent efforts at sexual rehabilitation are described. The interval be-

tween cancer treatment and vaginal reconstruction was more than 14 months in all except one patient. The McIndoe procedure formed the basis for the operative technique using skin grafts from the thigh. Innovations in operative technique which are described emphasize the use of latex hydraulic stents for the placement of skin grafts and the use of serosa of the small intestine as substrate for the skin graft. The stents used were either improvised from toy balloons or a specially prepared balloon-on-a-catheter stent was employed which proved to be more satisfactory. The use of a latex hydraulic stent is illustrated. After the perineal sinus is prepared, the balloon is distended with about 300 $cm^3$ of saline. Strips of skin graft are removed from the lateral part of the thigh or buttocks and fashioned in a cross shape to facilitate placement on the stent. The stent is then coated with neomycin-bacitracin ointment and the thick, split-thickness graft applied with the cornified surface toward the balloon before positioning it in the perineum in deflated form. After the balloon is in place, the stent is then restored to its previous 300 $cm^3$ volume, and the neck of the balloon is occluded with a ligature which is sutured to the perineal skin so that the stent cannot accidentally migrate into the pelvic peritoneal cavity. The perineal skin is sutured closed to prevent outward displacement of the stent. Commonly, fever, nausea, abdominal distention, and cramps were observed in the patients after vaginal reconstruction, presumably as signs and symptoms of mild regional peritoneal irritation, as they occurred most frequently if the skin graft was placed directly on the serosa of small intestine. The latex hydraulic stents were removed on the fifth postoperative day. Upon puncture of the balloon, it fell away from the skin graft which remained adherent to its bed, and no exudate was found and the graft always appeared healthy. Two other innovations were tried and abandoned: reflection of the gracilis muscle to the perineum for augmenting the blood supply of severely scarred tissues and incorporation of a portion of a nonfunctioning urinary bladder into the neovagina. The results were satisfactory, encouraging the belief that a substantial degree of sexual rehabilitation is possible in most women who are cured of advanced cancer by radical surgery or irradiation. (BBB)

**21923** MODIFICATION OF RADIATION-INDUCED DAMAGE IN DORMANT SEEDS. Hikoyuki Yamaguchi (Tokyo Univ.). p.9-17 of "Radiation Injury and Somatic Mutation." Ohmiya-machi, Ibaraki-ken, Japan, Inst. of Radiation Breeding, 1962.

Special emphasis was placed on what can be done to help the repair of radiation damage in dormant seeds of barley and rice. Successive fractions of a fractionated dose of x rays were additive in producing biological effects in dormant seeds and the treatments with long intervals between fractions gave more injury. When seeds were treated with cysteine and sodium hydrosulfite during the period following irradiation, the amount of radiation damage could be modified. Furthermore, it was found that the protective effect of sulfhydryl compounds was more marked in anaerobic than in aerobic irradiation of dry barley seeds. From these findings, the radiobiological processes in irradiation of dormant seeds were explained with radical mechanisms. (auth)

**21924** MODIFICATION OF RADIATION INJURY INDUCED IN GROWING PLANTS. Kazuo Hazama (Sericultural Experiment Station, Tokyo). p.19-29 of "Radiation Injury and Somatic Mutation." Ohmiya-machi, Ibaraki-ken, Japan, Inst. of Radiation Breeding, 1962.

The restoration, which is assumed to be another important factor for the modification of radiation injury, could not be referred to because of the shortage of space and the lack of sufficient data for the complete explanation of the mechanism of its action on higher organisms. A major aim was to make clear the mechanism of modification of radiation injury induced in growing plants, whereas it only emphasized the complexity of the mechanism. Also, the procedures proposed for the reduction of radiation injury are far from practical usage. Actually it will be difficult to find useful protective procedures for higher organisms, because their systems are extremely complex, and at the same time, they cannot tolerate wide variations of environmental conditions. However, from the standpoint of plant breeding, the reduction of radiation injury on growing plants under field conditions will be important for the development of gamma irradiation fields. (auth)

## Radiation Hazards and Protection

**21925** THE PRESENT STATE OF RADIATION CONTROL AT THE NATIONAL INSTITUTE OF RADIOLOGICAL SCIENCES. Hiroshi Sumida (National Inst. of Radiological Sciences, Chiba, Japan). Genshiryoku Kogyo, 9: No. 10, 49-58(Oct. 1963). (In Japanese)

The present state of radiation control at the National Institute of Radiological Sciences is described in detail, the author's personal views being added occasionally. The article consists of (1) how the radiation control and protection should be, (II) the works of radiation control and protection, (III) radiation control, (IV) radioactive waste disposal, (V) radiation accidents, and (VI) problems for the future. Radiation control is, in general, divided into direct protection of personnel from radiation and indirect protection by monitoring the radiation or radioactive facilities, but adequate radiation control is achieved only when the two are carried out side by side. In (II) above, the Radiation Health Control Unit, the Facility Safety Unit, and the Decontamination and Waste Disposal Unit are described, and in (III), the present state of radiation control of the various Institute facilities (RI experiments, $\alpha$-ray experiments, radiation generators, wards, etc.), blood examination, survey meters, etc. In (IV) are described the treatment and disposal facilities, the processes of waste treatment, liquid waste, and the radioactive feces and urine. Six years after the establishment, the facilities of the Institute are varied, and radiation uses range from basic studies to diagnosis and therapy. The radiation control and protection carried out under such conditions should provide examples of radiation control and protection for other similar institutions, and the practices and methods must be further improved. When considering the organization of radiation control of an institution, the factors listed below will also have to be considered: (1) the types of radiation work, (2) the scale of the institution, (3) the organization and structure of the institution, and (4) the type of radiation control service. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21926** USE OF VARNISH AND PAINT MATERIALS IN THE PRESENCE OF RADIOACTIVE IMPURITIES. V. B. Tikhomirov. Lakokrasochnye Materialy i ikh Primenenie, 6: 51-2(1963).

Radiation protective varnish and paint materials were developed on the basis of high-molecular-weight epoxy resins. The properties of these materials facilitate leaching out radioactive impurities with suitable solutions. These materials make it possible to increase the safety of working with radioactive materials without the expense of stainless steel. (C.H.)

# Radiotherapy and Radiodiagnosis

**21927** (UCRL-11184(p.121-7)) USE OF THE BRAGG PEAK FOR BRAIN-TUMOR THERAPY. Alexander Gottschalk, John T. Lyman, and Larry W. McDonald (California. Univ., Berkeley. Donner Lab.; California Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

Three patients with brain tumors were treated by the Bragg peak of the 910-Mev alpha-particle beam from the 184-in. synchrocyclotron. All had had subtotal tumor resection prior to therapy. The case histories are presented; the technique of dosimetry, and the method of irradiation are discussed. The series is too small to judge whether or not this form of therapy holds great promise for the future. (auth)

**21928** (WP/22/8) NUCLEAR MEDICINE. A Guide to Recent Literature. List No. 8. (International Atomic Energy Agency, Vienna). Feb. 1964. 75p.

A list is presented of 316 references to recent publications in the field of nuclear medicine. (C.H.)

**21929** (NP-tr-1135) MEASUREMENT OF THE CONTRAST TRANSFER FUNCTION OF X-RAY INTENSIFIER SCREENS. Manfred Hoefert. Translated by H. B. Andrews (U.K.A.E.A. Research Group. Harwell, Berks, Eng.), from Acta Radiol. Diagnosis, 1: 1111-22(1963). 24p. (Includes original, 7p.).

A method for the practical application of the contrast transfer theory to radiography is outlined, using the example of recording with intensifier screens. An apparatus is described for the production of x-ray sine grids, and the contrast transfer functions for various screen combinations are considered. (auth)

**21930** DETECTION OF METASTATIC CANCER TO BONE BY SCINTISCANNING WITH STRONTIUM 87m. N. David Charkes, David M. Sklaroff, and James Bierly (Albert Einstein Medical Center, Philadelphia). Am. J. Roentgenol., Radium Therapy Nucl. Med., 91: 1121-7(May 1964)

Sixteen patients were injected with $^{87m}Sr$ and photoscans made of bone. Seven of these patients had metastatic cancer to bone and 4 had primary bone tumors. Except for 2 patients with eosinophilic granuloma, the $^{87m}Sr$ scans corresponded with the roentgenograms, and in 6 patients revealed more extensive disease than did the roentgenograms. Bone biopsy in 5 patients confirmed the scan findings. In 6 patients injected with both $^{87m}Sr$ and $^{85}Sr$, identical scans were obtained. $^{87m}Sr$ can be employed to detect metastatic cancer to bone even prior to observable roentgenographic changes. It should prove of particular value in evaluating nonmalignant disorders of bone including those of children, and in following the osteogenic response to therapy of bone diseases. (auth)

**21931** OBSERVATIONS OF ISOTOPE HEPATOSCANNING IN DIAGNOSIS AND TREATMENT OF AMOEBIC LIVER INFECTION. Kurt Marberg and Pinchas Czerniak (Tel-Hashomer Government Hospital, Israel). Ann. Internal Med., 60: 66-78(Jan. 1964).

Scanning examinations of the liver with $^{198}Au$ were carried out in five additional cases having clinical signs of amoebic liver infection. Exact spacing of amoebic liver lesions is important in cases to be explored or treated surgically by closed or open drainage. It can be achieved by the application of a three-plane scannographic method. Consecutive performance of several scannographic examinations can be utilized for study of the natural course of amoebic liver infection, as well as to visualize progress and results of chemotherapy or surgical treatment. Scannographic examinations indicate that in cases of amoebic hepatitis or abscess there is full recovery within a period of two to six months in a great majority of the cases. While from a clinical point of view three of the cases studied were thought to be amoebic hepatitis and two were proved to be amoebic abscesses, the scannographic picture in all five of them revealed empty, confined, round lesions. The question of the existence of diffuse amoebic hepatitis, recently raised again in the literature, is discussed in the light of the above findings. Liver scanning with radioactive Au does not appear to constitute a serious radiobiological risk for the patient examined. (auth)

**21932** A NUMERICAL METHOD FOR THE DETERMINATION OF MOVING FIELD ISODOSE CURVES FOR TREATMENT PLANNING IN RADIOTHERAPY. Glenn V. Dalrymple and Ruheri Perez-Tamayo (Univ. of Colorado, Denver). Commun. Assoc. Computing Machinery, 6: 625-6 (Oct. 1963).

A computer technique is described for the determination of moving field isodose curves for use in planning supervoltage x radiation treatments. (C.H.)

**21933** COLOR SCINTISCANNING OF THE RADIOISOTOPE DISTRIBUTION IN THE BODY. Hirotake Kakei and Noboru Arimizu (Chiba Univ., Japan). Genshiryoku Kogyo, 9: No. 9, 26-31(Sept. 1963). (In Japanese)

In scintillation scanning of the radioisotope distribution in the body, the intensity of radiation is expressed by the dot density or degree of blackening. In this method, slight variations in intensity of radiation (below 15%) expressed as a count rate are not detected on the scintigram. The new method, which divides the intensity of radiation detected by scintiscanners into several color channels according to their intensity, expresses the intensity as change in color, and also includes the element of dot density, is investigated. The color scintiscanning methods are divided into (1) the count rate counter method which divides the intensity into several color channels according to the count rate, (2) the fixed count counter method which estimates the intensity by the interval of pulses and expresses the different intervals as several colors, (3) the fixed time counter method which estimates the intensity by the count within a constant time and expresses these different counts as several colors, and so on. These methods have advantages and disadvantages respectively. Therefore, investigations must be made to determine which method is superior to other methods. By this color scintiscanning method, the accuracy of diagnosis of tumors of the liver and brain will be increased. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964)).

**21934** THE INFLUENCE OF RADIOACTIVE STRONTIUM ON THE COURSE OF HEALING OF EXPERIMENTAL RICKETS IN RATS TREATED WITH VITAMIN $D_2$. T. Giza, M. Hanicka, N. Hornik, A. Jelonek, and H. Rembiesa (Jagiellonian Univ., Krakow). Intern. Z. Vitaminforsch., 33: 227-34(1963).

Rats fed a rachitogenic diet for six weeks were treated with vitamin $D_2$. They were divided into three groups of 10, of which those in group I were given a single dose of 5 $\mu C$ $^{90}Sr$, those in group II were given 1 $\mu C$ $^{90}Sr$ five times with two-day intervals between doses, and group III served as controls. Evaluation of healing of rickets was made by: measurement of the space between the visible end of the shaft of the tibia and the adjacent epiphyseal ossification center on x-ray films before and during treatment, after

5, 10, and 15 days; and determination of alkaline phosphatase activity and of the serum inorganic phosphorus level at the beginning and end of the experiment. A significant retardation was found in the healing of bones and in the normalization of disturbed metabolic processes in the groups of rats receiving $^{90}Sr$, compared with the control group. By day 15 the mean width of the epiphyseal space in group II was 1.38 cm, and in groups I and III 0.90 and 0.73 cm, respectively. Before the experiments the mean value of serum alkaline phosphatase was 31.4 Bodansky units. Distinct changes were noted after 15 days, with group I 22.8, group II 19.1, and group III 18.6 units. At the beginning of the experiment the mean value of serum inorganic phosphorus was 6.5 ± 1.3 mg%; after 15 days the respective levels in the three groups were 4.9, 3.9, and 4.9 mg%. Differences in behavior were also noted; rats belonging to group I were apathetic, showing poor appetite and bristling hair, and two animals died during the experiment. The animals of group II showed excessive motor excitability, but all the animals survived the experiment. The general condition and behavior of the animals in the control group were normal. (BBB)

**21935** DOSE MEASUREMENTS AND DOSE DISTRIBUTION. 1. ON THE ISODOSE CURVE OF THE TELECOBALT UNIT. Hiroshi Tsunemoto (Namazu National Hospital, Shizuoka, Japan). Iryo (Tokyo), 16: 621-3(Dec. 1962). (In Japanese)

Depth-dose, absorption, and isodose curves for a $^{60}Co$ therapy unit are shown. (BBB)

**21936** SUSPENSIONS OF RADIOALBUMIN AGGREGATES FOR PHOTOSCANNING THE LIVER, SPLEEN, LUNG AND OTHER ORGANS. G. V. Taplin, D. E. Johnson, E. K. Dore, and H. S. Kaplan (Univ. of California, Los Angeles and Los Angeles County Harbor General Hospital, Torrance, Calif.). J. Nucl. Med., 5: 259-75(Apr. 1964).

Current methods of preparing small and large size suspensions of radioalbumin aggregates by heat treatment and pH adjustment are presented. The small size colloidal suspensions (10 to 20 mμ) are shown to be superior to other agents for liver-spleen scanning. Radiation exposure to these organs is minimized and the albumin suspensions can be prepared with relative ease and simplicity. Also the heart, stomach, and salivary glands may be clearly visualized by photoscanning with this material. The techniques and physiological basis for performing and interpreting scans of these organs are described. Their diagnostic value is illustrated. The preparation and physiological basis for using large size suspensions of the same material for visualization of the lungs is presented along with scans typical of those produced with suspensions of each of two size ranges (2.5 and 15 μ). The smaller size is preferable because of far less probability of capillary embolization. Trials in patients with lung cancer will be initiated after additional animal studies ensure the complete safety of the test procedure. (auth)

**21937** A STAINING TECHNIC TO DEMONSTRATE EFFECTS OF IONIZING RADIATION IN THE THYROID GLAND. James C. Stinson, James C. Moore, and Arno W. Sommer (Scott and White Clinic, Temple, Tex.). J. Nucl. Med., 5: 276-80(Apr. 1964).

Human and guinea pig thyroid glands were used to develop a straining technique whereby areas where ionizing energy is or apparently was located could be detected histologically. Sections of tissue prepared by the technique were given to pathologists for objective evaluation, and in each case the irradiated tissue was identified. The black granular material observed in the cytoplasm of the acinar cells is presumed to represent areas in which ionizing energy was or is present. This presumption is based upon the presence of a large number of granules observed in thyroid tissue known to have been exposed to $^{131}I$ during life and conversely upon a sparsity or absence of these granules in tissue in which there was no known exposure to $^{131}I$. As the control tissues studies were processed during the same period as the treated glands, radioactive material in the atmosphere would not appear to be a problem. The histologic variation suggests a radioinduced alteration in the chemical composition of the cells. The dark granules in the cytoplasm probably represent areas of differential staining secondary to the ionizing energy rather than to the actual location of the radioactive focus. These changes may represent the vacuoles seen in cells of extensively irradiated tissue when hematoxylin and eosin stains are used. In any event, the granular areas are well localized in the cells. In the development of this technique, most of the tissue utilized was from the thyroid gland. Application of the staining technique to blood and other tissues, however, seems to indicate that histologic alterations secondary to radiant energy may be localized in these other tissues. (H.M.G.)

**21938** RADIOLOGY IN THE PRACTICE OF RURAL MEDICINE: TECHNIQUE, HAZARDS, PREVENTION. C. Beraud. Lyon Med., 94: 1621-51(June 24, 1962). (In French)

The possible hazards encountered in diagnostic radiology in general practice are discussed. (BBB)

**21939** PROSPECTS OF UTILIZING RADIOACTIVE COLLOIDS FOR THE TREATMENT OF MALIGNANT AFFECTIONS OF LYMPH NODES. V. V. Sedov, N. G. Serebryakov, and N. F. Tarasov. Med. Radiol., 9: No. 3, 3-12 (Mar. 1964). (In Russian)

Subject to investigation was the accumulation of 12 different radioactive colloidal solutions ($^{198}Au$, $^{32}P$, $^{111}Ag$, and $^{90}Y$) in the lymph nodes and internal organs (liver, kidney, spleen, etc.) in their intralymphovascular introduction. The greatest accumulation of the radioactive substance in lymph nodes with its minimal accumulation in internal organs was noted in intralymphovascular administration of a colloidal solution of $^{198}Au$ and radiogold, adsorbed on activated carbon, as well as in aqueous and lactose media. It is shown that with an augmented volume of the solution introduced the percentage of its accumulation in lymph nodes decreases. The method of intralymphovascular administration of radioactive colloidal solutions makes it possible to ensure local irradiation of lymph nodes in curative doses. The internal organs (liver, kidneys, etc.) receive 100- and even 1000-fold lesser tissue doses at the expense of beta radiation. The results of clinical employment of this method in patients suffering from mammary gland carcinoma are presented. (auth)

**21940** THE PROBLEM OF THE EFFECTIVE USE OF ISOTOPIC TECHNIQUES IN CLINICAL RESEARCH. Wladyslaw Jasinski (Oncological Inst., Warsaw). Nowotwory, 12: 365-75(1962). (In Polish)

Theoretical and practical aspects of scintiscanning are discussed. (BBB)

**21941** ROENTGENPOLYPRAGMASIA AND MEDICAL PRACTICE. Janos Barany. Orv. Hetilap, 102: 1084-6 (June 1961). (In Hungarian)

Government regulations relating to x-ray examination procedures and radioprotection are discussed. (BBB)

**21942** A TWO-KILOCURIE CESIUM-137 TELETHERAPY UNIT. I. DESCRIPTION OF UNIT. Fumio Kinoshita (Okubo Municipal Hospital, Tokyo) and Motoyuki Kitsukawa. Radioisotopes (Tokyo), 12: 408-17(Nov. 1963). (In Japanese)

In 1960 a two-kilocurie $^{137}Cs$ beam unit was installed in Okubo Municipal Hospital of Tokyo. It consists of a head suspended in a yoke and supported from the ceiling. The design and construction of this unit are shown schematically in this report. The source prepared in Oak Ridge is carried on a source wheel, which rotates 180 degrees by an electric motor. The collimator is designed to give any rectangular field size from $4 \times 4$ to $16 \times 16$ cm$^2$ at 50 cm. The multileaf diaphragm consists of a main diaphragm and extension diaphragms. The heights of two extension diaphragms are 10 and 20 cm respectively. Protection measurements were made on the surface of the head, and the maximum value seen at only one point was 5.4 mr/hr. The values at other points were all less than 3 mr/hr. At one meter from the head the values were less than 0.18 mr/hr when the beam was off. Radiation outside the room when the beam was on was less than 0.03 mr/hr. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21943** A TWO-KILOCURIE CESIUM-137 TELETHERAPY UNIT. II. PHYSICAL MEASUREMENTS. Fumio Kinoshita (Okubo Municipal Hospital, Tokyo) and Motoyuki Kitsukawa. Radioisotopes (Tokyo), 12: 409-18(Nov. 1963). (In Japanese)

The half value layers obtained were 5.2 mm of Pb and 10.3 mm of Cu. The output of this unit was found to be 30.0 r/min in air with $16 \times 16$ cm$^2$ field size at 50 cm from the source in Oct. 1960. Variations of air dose rate in the central axis were measured by changing field sizes. The extension and the dose distribution about the penumbra were calculated by dose meter and x-ray film and these were compared with $^{60}Co$. Isodose distributions at 50 cm SSD for the field sizes of $4 \times 4$, $4 \times 10$, $6 \times 6$, $8 \times 8$, $8 \times 10$, $10 \times 10$, $10 \times 12$, $12 \times 12$, $15 \times 15$ cm$^2$ were also compared with $^{60}Co$. The main advantages of $^{137}Cs$ beam therapy compared with $^{60}Co$ depend upon its longer half life, 33 years, and its production in enormous quantities in every pile as a fission product, which makes $^{137}Cs$ much cheaper than $^{60}Co$. $^{137}Cs$ emits gamma radiation with an energy of 662 kev, and the percentage depth dose resembles that of 1 Mv x rays. The main disadvantage of $^{137}Cs$ results from its low specific activity. The $^{137}Cs$ unit appears to be a useful radiotherapeutic tool in the treatment of relatively shallow tumors, for example, metastases of breast cancer or tumors in the head and neck regions. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21944** TREATMENTS BY A 15-Mev MEDICAL BETATRON. Moriji Fujino and Tokutaro Miyauchi (Osaka City Univ.). Rinsho Hoshasen, 8: 398-401(June 1963). (In Japanese)

The results of treatments by x rays from a 15-Mev medical betatron obtained over about 1.8 yr after May 1961 are described and discussed. The irradiations were made with a focus skin distance of 60-80 cm, a maximum field of $10 \times 15$ cm, x-ray output power of 10-25 r/min, at 3 cm of Lucite. As results, 11 cases in 19 of lung cancer, 4 cases in 10 of esophagus cancer, and 8 cases in 13 of uterus cancer markedly improved. In 9 cases of 12 of tumor of the pharynx and larynx, tumors disappeared. The x rays of the betatron caused decrease of appetite and malaise in less than 60% of the patients treated and headache, dizziness, and nausea in less than 5%. The variation of blood elements was only slight during irradiation, and only 4 cases of 84 needed blood transfusions because of anemia and leucopenia. Slight dermatitis was observed in the patients who received 12,000 r (deep doses). The x rays of a betatron are superior to conventional x rays in aftereffects, but a betatron still has some drawbacks in technical matters such as unstable output and inability to irradiate evenly. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21945** ON HUMAN SKIN REACTIONS IN DEEP X-RAY AND $^{60}Co$ $\gamma$-RAY TREATMENT. Toshihiko Tanaka (Yokohama City Univ., Japan) and Ryukichi Nagai. Rinsho Hoshasen, 8: 415-24(June 1963). (In Japanese)

Comparative histopathological examinations of human skin biopsy specimens irradiated with $^{60}Co$ $\gamma$ rays and with high voltage x rays were made. Of 24 cases irradiated with $^{60}Co$ $\gamma$ rays, 13 were biopsied within 10 days of irradiation, and 11 were biopsied from one to several months after irradiation. All cases irradiated with high-voltage x rays were biopsied within 10 days of irradiation except one. Considerable difference in skin reactions between individuals was found. Generally x irradiation produced greater changes than $^{60}Co$ irradiation in the upper layer of the corium. Changes in blood vessel dilatation in the deep layer of the corium and atrophy of sweat glands within subcutaneous tissue were a little larger in x-irradiated cases. The epidermis, corium, and subcutaneous tissue were uniformly injured in x-irradiated cases, but in $^{60}Co$-irradiated cases, injury to the subcutaneous tissue was very large compared to injury to the epidermis. In $^{60}Co$ high irradiations or in long-term-after-irradiation cases, not only degeneration in the corium but also at times marked fibrosis in fatty tissue were seen. Similar changes were seen in 40-day 5000–8000 rad $^{60}Co$ treatments and 40-day 4000–5000 rad high-voltage x-ray treatments. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**21946** THE RESULTS OF HIGH-ENERGY TREATMENTS. Koichi Murakami (Kyushu Univ., Japan). Rinsho Hoshasen, 8: 425-7(June 1963). (In Japanese)

Patients with malignant tumors were treated using a type BT-15 (Shimadzu) betatron, which generates x rays and electron beams of up to 15 Mev, from Jan. 1961 to Dec. 1962. The report deals with 54 patients including 22 cases of tumor of the digestive tract, 5 of the lung, 4 of the femoral region, etc. The beams used were 15-Mv x rays, and 10- and 15-Mev electron beams. The number of treated patients was 48, 3, and 3, respectively. The death rate for these patients was about 30%, considerably higher than those for other patients treated by ordinary beam therapies. Most of the patients treated with the betatron were in incurable terminal conditions. Although the betatron has many advantages, high curative values cannot be expected from these patients. When this beam therapy was compared with other ordinary treatments, it was found that side effects such as nausea, vomiting, etc., were observed in only one patient. This is probably because the penumbra of the high-energy x ray is smaller and the high-energy electron beam acts only on the region of treatment. No dermoreaction was observed with 15 Mv x rays, and it was much less than expected in the high-energy electron beams. A 20% decrease in leukocytes was observed in 7 of the 24 patients treated with the high-energy x rays, which is the same as in ordinary telecobalt therapies. In high-energy electron-beam treatments, an increase in leukocytes was observed in only one patient. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

# CHEMISTRY

## General

*Refer also to abstracts 21759, 22552, and 23139.*

**21947** (ORNL-3591) REACTOR CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JANUARY 31, 1964. (Oak Ridge National Lab., Tenn.). May 1964. Contract W-7405-eng-26. 284p.

Research progress in reactor chemistry is reported under 28 topics. Separate abstracts were prepared for each. (M.C.G.)

*For abstracts of individual papers see: 22010, 22011, 22012, 22013, 22014, 22015, 22016, 22017, 22018, 22019, 22111, 22112, 22113, 22172, 22173, 22174, 22276, 22277, 22446, 22490, 22491, 22528, 22529, 22530, 22946, 23002, 23061, and 23099.*

**21948** (TID-18865) OFFICIAL USAEC VALUES FOR AMOUNT OF U-235 ISOTOPE IN NATURAL URANIUM. (Atomic Energy Commission, Washington, D. C.). May 27, 1963. 6p.

In view of the fact that the $^{235}U$ content in natural uranium varies from 0.7103 to 0.7113%, it was decided that the official USAEC value shall be changed from 0.7115 to 0.711%. The NBS uranium ore standards are discussed briefly. (D.L.C.)

**21949** THE EFFICIENCY OF ISOTOPIC SUBSTITUTION BY EXCHANGE. W. O. George (Kingston Coll. of Tech., Kingston-upon Thames,Eng.). Chem. Ind. (London), No. 12, 481(Mar. 21, 1964).

Deuterium substitution is often used when making vibrational assignments in molecules containing X-H groups, either by synthesis using a pure D compound or by exchange. The fraction of D/H in the deuteration product is measurable by mass spectroscopy or NMR. If more than one X-H group is substituted, the amounts of various deuterated species will follow a binomial distribution if no difference in reactivity between exchangeable hydrogens occurs. The amount of residual undeuterated compound may be estimated from the infrared spectrum. It is frequently assumed that when this estimated amount is low, the observed vibrational bands are attributable to the fully deuterated molecule. However, it is shown that even when the amount of X-H compound in the exchange product is extremely low (about 0.01%) substantial amounts of partially exchanged compounds are present. When several per cent of initial X-H compound occur, then the proportion of fully exchanged X-D compound present may be extremely low. It is assumed that no specific effects are present leading to a difference in reactivity between the labile hydrogens. An expression is derived by considering a compound containing n labile X-H groups. The probability of exchange taking place on any one group is x, and of not taking place is (1-x). The mole fraction of a species containing i X-D groups, and (n-i) X-H groups is: $M_i = [n!\ x^i(1-x)^{n-i}/i!\ (n-i)!]$. The mole fraction of the totally undeuterated species is: $M_0 = (1-x)^n$. This expression allows x to be calculated from the estimated amount of undeuterated species present. A table is provided which shows the calculated percentage of each species present for molecules containing up to four labile H atoms for various amounts of unchanged starting material. This indicates that, while it is permissible to identify X-H frequencies by the changes which follow D substitution, caution must be exercised in assigning bands from the spectrum of the product to a fully deuterated molecule on the basis of low concentration of initial material. (BBB)

**21950** THE DETERMINATION OF THE NEUTRALIZATION OF CONCRETE BY USING RADIOACTIVE CARBONIC ACID GAS. A. Ariizumi, O. Kondou, and M. Makita (Public Works Research Inst., Tokyo). Semento Konkuriito, No. 187, 14-18(Sept. 1962). (In Japanese)

Cylindrical mortar samples (5 cm $\phi \times 10$ cm) prepared under various conditions were immersed in water for 0.5 to 1.5 yr, followed by a drying period of either 4 to 7 hr in a vacuum, or 7 months in a lab. Then the vacuum and natural-dried samples were placed in reactors containing 0.5 mC and 1 mC $^{14}CO_2$, respectively, for 2 months. Autoradiographs of the central cross sections of both sets of mortars are discussed with respect to (1) a comparison of the phenolphalein color reactions, (2) the effects of drying condition of sample, (3) the mixing components of the cement, (4) the type of cement, (5) the water cement ratio, (6) the cement content, and (7) grain size of sand. It was concluded that the neutralization rate was accelerated for (a) a drier mortar, (b) a mixed cement rather than Portland cement, (c) a 74% water-to-cement ratio is better than a 56% ratio, (d) a concrete containing a smaller cement portion, and (e) coarser sand grains. (OID)

**21951** RADIO-GAS-CHROMATOGRAPHIC INVESTIGATIONS WITH THE PROPORTIONAL COUNTER. K. H. Lieser, H. Elias, and F. Sorg (Technische Hochschule, Darmstadt, Ger.). Z. Anal. Chem., 191: 104-15(1962). (In German)

Radio-gas-chromatography can be used for the examination of volatile radioactive compounds. A combination of gas-chromatography and proportional counters offers certain advantages providing that the counter is directly built in the thermostatic vessel of the gas chromatograph operated by a carrier gas serving also as a counting gas. The gas must have a much higher heat conductivity than the test sample, and be able to produce a sufficiently long and flat plateau at a low tension. Methane gas best meets these requirements. The apparatus is described in detail with respect to its calibration, operation, and measurement techniques. The separation of inactive n-butyl chloride and tertiary butyl chloride tagged with $^{36}Cl$ is given as an example. Activity as low as $10^{-3}$ $\mu$C of $^{36}Cl$ can be detected with an accuracy of ±10%. The effect of the admixtures of inactive substances and the determination of the necessary corrections by means of calibration curves is also discussed. (auth)

**21952** FRIEDEL-CRAFTS AND RELATED REACTIONS. VOLUME I. GENERAL ASPECTS. George A. Olah, ed. New York, Interscience Publishers, 1963. 1062p.

Information is included on the historic aspects of the Friedel-Crafts reaction; definition and scope of the reaction; proton and Lewis acids; catalysts and solvents; Lewis acid catalysts in non-aqueous solutions; coordination compounds of the boron halides; coordination compounds of aluminum and gallium halides; intermediate complexes; spectroscopic investigations; application of isotopic tracers to the study of reactions; reactivity and selectivity; thermodynamic aspects; and stereochemical aspects. (P.C.H.)

# Analytical Procedures

**21953** (AERE-R-4576) APPLICATIONS OF A NEUTRON GENERATOR IN RADIOACTIVATION ANALYSIS. D. Gibbons and G. Olive (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Nov. 15, 1963. 23p.

A typical neutron generator installation is described, with emphasis on shielding, flux monitoring, sample transfer systems, and associated counting and control equipment. Various aspects of the use of neutron generators are illustrated by reference to different practical analyses, and some problems associated with the resolution of complex gamma spectra are discussed briefly. (P.C.H.)

**21954** (ANL-6817) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART VI. A. THE ABSORPTION SPECTRUM OF PLUTONIUM HEXAFLUORIDE. B. ANALYSIS OF MIXTURES OF PLUTONIUM HEXAFLUORIDE AND URANIUM HEXAFLUORIDE BY ABSORPTION SPECTROMETRY. Martin J. Steindler and William H. Gunther (Argonne National Lab., Ill.). Jan. 1964. Contract W-31-109-eng-38. 16p.

The absorption spectrum of gaseous plutonium hexafluoride was determined over the range of wavelengths from 2000 to 26,000 Å, and molar absorbancy indices were calculated. A test of the spectral method of analysis of plutonium hexafluoride in mixtures of plutonium hexafluoride and uranium hexafluoride was made. The results indicated that plutonium hexafluoride may be determined in mixtures containing uranium hexafluoride by use of a spectral method although care is required to pretreat the cell windows to avoid reaction with plutonium hexafluoride. (auth)

**21955** (CONF-117-42) MACRO DETERMINATION OF OXYGEN IN METAL OXIDES BY INERT GAS FUSION. Ben D. Holt and John E. Stoessel (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 27p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The inert gas fusion method was extended to the direct determination of oxygen in metal oxides on a milligram scale to take advantage of increased precision in measurement data. Sample sizes, depending on the molecular weights of the oxides, ranged from 50 to 200 mg. About 100 mg of $CO_2$, produced by the procedure, was collected in absorption weighing tubes and measured on a standard analytical balance. In the analysis of pure oxides ($Fe_2O_3$, $SiO_2$, $Al_2O_3$, $Cr_2O_3$, $UO_2$, $Ta_2O_5$, and $TiO_2$) average recoveries of 99 to 100% of the theoretical oxygen content were obtained, with standard deviations from the means of about 0.5%. The same degree of precision was obtained in the analysis of standard samples of refractory oxide mixtures, glass, and silica brick. The temperature of the covered graphite crucible was controlled to prevent the loss of sample by entrainment during the carbon-reduction of the oxides. (auth)

**21956** (HW-77581) TREATMENT OF URINALYSIS OFF-GASES. M. R. Schwab (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 31, 1963. Contract AT(45-1)-1350. 19p.

The routine detection of individual exposures to internally deposited radionuclides is based primarily on bioassay techniques that include urinalysis. A urinalysis procedure is described that includes a digestion phase, an isolation phase, and a radiation-counting phase. The control of toxic and odorous fumes produced during the digestion phase of the urinalysis procedure is discussed in detail. (C.H.)

**21957** (HW-SA-2118) DETERMINATION OF NITRATE BY CONTROLLED POTENTIAL COULOMETER. Lee R. Duncan (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 23, 1961. Contract AT(45-1)-1350. 12p.

A coulometric titration method for the determination of nitrate ion was developed based upon the catalytic reduction of nitrate by uranium(III). The reduction proceeds quantitatively to nitrogen gas at a mercury cathode which is controlled at a potential of −1.0 volt versus a saturated calomel electrode. The titration is rapid and a complete analysis can be made in 20 minutes. Standard deviations of ±0.5% in the 0.1 to 0.5 milligram sample size range were demonstrated. The only commonly occurring interferences were zinc and agents that compled uranium(VI) and uranium(IV). Thus the specific nature of the method made it generally applicable to research and engineering needs. (auth)

**21958** (KY-456) ISOTOPIC EVALUATION OF SECONDARY GENERATIVE URANIUM STANDARDS. R. F. Smith, R. E. Eby, and C. W. Turok (Paducah Gaseous Diffusion Plant, Ky.). Mar. 20, 1964. Contract W-7405-eng-26. 29p.

Two uranium isotopic standards, designated as Secondary Generative Materials by the National Bureau of Standards, were evaluated. A value of 0.01750 ± 0.00003 wt % $^{235}U$ was obtained for the Depleted Secondary Generative Standard by averaging the results from three independent analytical methods. The assay obtained for one batch of the Enriched Secondary Generative Standard was 94.532 ± 0.007 wt % $^{235}U$; however, a value of 94.536 was adopted because of minor assay differences between available batches. (auth)

**21959** (RFP-210) DETERMINATION OF ALLOYING MATERIAL IN PLUTONIUM ALLOYS. R. P. DeGrazio and F. J. Miner (Dow Chemical Co. Rocky Flats Plant, Denver). Sept. 30, 1960. Contract AT(29-1)-1106. 30p.

A procedure was developed for determination of gallium in plutonium-gallium alloys. An ion exchange method is used to separate the gallium from the plutonium. The gallium is then determined by an EDTA titration. Of the impurities common to the samples only copper, if present in concentrations greater than 250 ppm in the alloy, will interfere and an alternate, more lengthy procedure is given to eliminate its interference. The precision and accuracy of the procedure was measured and results obtained using it were compared with results obtained on the same samples by the widely used solvent extraction-colorimetric procedure. (auth)

**21960** (SC-TM-64-534) EVALUATION OF A MODIFIED ILFORD Q2 PHOTOGRAPHIC EMULSION FOR MASS SPECTROGRAPHIC USES. J. W. Guthrie (Sandia Lab., Albuquerque, N. Mex.). Apr. 1964. Contract [AT(29-1)-789]. 17p.

The results are presented of tests made to compare a modified Ilford Q2 emulsion with that of present production Ilford Q2 emulsions for use as ion detectors in a mass spectrograph. (auth)

**21961** (UCRL-11184(p.98-103)) AN IMPROVED METHOD FOR THE COMPUTER ANALYSIS OF GAS-LIQUID CHROMATOGRAMS. Alicia M. Ewing, Pamela P. Walker, Robert D. Willis, and Frank T. Lindgren (Cali-

fornia. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

An improved method for the computer analysis of gas-liquid chromatograms is presented. The analytical results are presented in terms of the relative mass, relative retention time, and percentage composition of each component of the chromatogram. In addition, the procedure provides for the optional calculation of absolute mass, correction of calibration factors, peak height correction for unresolved components and subtraction of contaminating components from each chromatogram. (auth)

**21962** (UCRL-11184(p.104-9)) INFRARED MICRO-METHOD FOR SERUM TRIGLYCERIDES AND CHOLESTERYL ESTERS. Norman K. Freeman (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

Further experience with an infrared spectrophotometric method for the determination of serum triglycerides and cholesteryl esters is reported. Two new aspects considered are the use of a single-step combined extraction and adsorption procedure, and the feasibility of analyzing 0.05-ml serum samples. The simplified extraction, in comparison with the two-step procedure, was found to be substantially equivalent in accuracy and slightly poorer in precision. Analysis on the micro scale is a promising extension of the method, although preliminary results are not quite comparable with those from larger samples. (auth)

**21963** DETERMINATION OF TRACE QUANTITIES OF TIN BY NEUTRON ACTIVATION ANALYSIS. H. Hamaguchi, K. Kawabuchi, N. Onuma, and R. Kuroda (Tokyo Kyoiku Univ.). Anal. Chim. Acta, 30: 335-45(Apr. 1964).

A neutron activation method of general applicability was developed for determining traces of tin in a variety of samples. The samples and comparative standards, sealed into ampoules, are irradiated intermittently for 3 days at a neutron flux of ca $3 \times 10^{11}$ n/cm$^2$/sec, followed by carrier radiochemical separations mainly consisting of solvent extraction steps. As little as 0.1 $\mu$g Sn can be easily determined by comparing the induced $\beta$-activity of $^{121}$Sn (27.5 h) with that of a standard. The method is rapid and has a reasonably high chemical yield of about 50%. Results are quoted for the tin contents of a number of materials including silicate rocks, sea waters, biological materials, and steels. (auth)

**21964** TITRIMETRIC DETERMINATION OF $Nd^{3+}$ WITH SODIUM TUNGSTATE IN THE PRESENCE OF ADSORPTION INDICATORS. Wiktor Wawrzyczek and Alina Bukowska (Landwirtschafliche Hochschule, Olsztyn, Poland). Anal. Chim. Acta, 30: 401-3(Apr. 1964). (In German)

The reaction $2Nd^{3+} + 3WO_4^{2-} \rightarrow Nd_2(WO_4)_3$ served as the basis for a neodymium determination method. $Nd^{3+}$ is titrated with sodium tungstate. Tests were carried out on known standards and results varied from calculated values by 0.11 to 0.75%. Between 0.0045 and 0.18 g of neodymium could be determined in 5 to 25 ml of solution. (M.C.G.)

**21965** A NEW SPECIFIC SPOT TEST FOR URANYL IONS BASED ON THE BEHAVIOUR OF PROTONATED SCHIFF BASES OF p-DIMETHYLAMINOANILINE WITH AROMATIC ALDEHYDES. Ervin Jungreis and Lina Ben-Dor (Hebrew Univ., Jerusalem). Anal. Chim. Acta, 30: 405-7(Apr. 1964).

A specific spot test method using protonated Schiff bases of p-dimethylaminoaniline with aromatic aldehydes is described for the determination of uranium. A concentrated alcoholic solution of p-dimethylaminoaniline hydrochloride mixed with a concentrated alcoholic solution of salicylaldehyde is used. The solution is poured on paper and dried until it turns yellow. Iron(III) is the only interference. However, owing to different rates of capillary diffusion on the dried reagent paper, a mixture of uranium and iron gives a central blue-violet spot surrounded by a well-defined red ring, thus overcoming interference and avoiding prior removal. (P.C.H.)

**21966** THE MEASUREMENT OF SOLID AND LIQUID MIXTURES OF RADIOACTIVE SUBSTANCES. Rolf Piesch (Siemens & Halske AG, Karlsruhe, Ger.). Atomkernenergie, 9: 115-21(Mar.-Apr. 1964). (In German)

A previous paper showed how individual known isotopes can be measured with detectors, which are calibrated with potassium-40. In general, the energy of the isotopes to be measured differs from the radiation energy of $^{40}$K. Therefore, correction factors have to be applied, which are denoted as calibration factors. Their calculation was subject of the previous paper. The same considerations are extended for mixtures of radioactive substances. For this purpose the mixtures are divided in the following groups: (1) qualitatively and quantitatively known mixtures; (2) qualitatively known mixtures; (3) boundary value mixtures in which only the lowest occurring energy is known; and (4) completely unknown mixtures. Only for mixtures of group 1 can the calibration constants be calculated with the mixture data on hand. The specific activity can then be measured without difficulty. In the case of mixtures of group 2 it is possible to carry out a kind of filter analysis. The quantities $q_i$ of the individual isotopes in the mixture are obtained as coefficients of linear equation systems, which can be solved either with determinants or by successive elimination. The mixtures of group 3 only allow the denomination of an upper and a lower calibration constant as boundary values. The true unknown value lies in between. The distance of the boundary values can be diminished considerably by reduction of sample thickness and foil thickness of the detector. The mixtures of group 4 cannot even be measured approximately. One has to try rather by appropriate means to obtain information on the sample composition in order to apply one of the methods described so far. Examples show the practical application of the methods described. (auth)

**21967** NEW METHOD FOR THE MEASUREMENT OF RADON BY SCINTILLATION. J. Dujardin, N. Bonningue, M. Fontan, and R. Cuvelier. Atti Congr. Intern. Idrol. Climatol., Ischia, Italy, Oct. 4-8, 1958, 539-46(1962). (In French)

Bubbling air in water containing radon carries the radon gas away with it. The mixed gases, air and radon, after concentration and desiccation are introduced into a balloon, the inner surface of which has been coated with zinc sulfide powder activated with silver, and the bottom replaced by a highly transparent glass disk. The balloons are placed in front of a photomultiplying set that transforms light impulses into electric impulses. An electronic computer notes the results. The radioactivity of the thermal waters to be measured is compared to that of a standardized solution of radium. Thus, results are directly obtained. The dosage of radium salts is established in the same way, but only when radium-radon equilibrium has been obtained after 30 days. The results of some measurements are given. (P.C.H.)

**21968** DETERMINATION OF POLONIUM BY DITHIZONE EXTRACTION. Takashi Ashizawa and Kanji Haru-

yama (Atomic Fuel Corp., Tokyo). Bunseki Kagaku, 13: 11-16(Jan. 1964). (In Japanese)

Polonium ($^{210}$Po) was extracted with dithizone-carbon tetrachloride solution ($5 \times 10^{-4}$ M) in 1N nitric acid, decomposed with concentrated nitric acid, and dried on a planchet. Then $\alpha$ activity was measured by a gas flow proportional counter or a Geiger-Mueller counter, the counting efficiencies of which were 34.6 ± 2.7% and 5.77 ± 0.14% (95% C.L.), respectively. The extraction of polonium by one extraction was 99.4%, and its separation from 100 mg copper, 20 mg mercury, 500 mg bismuth, and 500 mg tellurium was possible by selecting suitable extracting conditions. Lead and nickel did not interfere. Halogen ions caused disturbance in acid medium. Extraction from alkaline solution containing cyanide ions was possible. This method is suitable for control analysis of polonium in uranium refining processes. The time required for an analysis is about 2 hr. The error of analysis is 10% (95% C.L.). (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21969** DETERMINATION OF OXYGEN IN ZIRCALOY BY ARGON CARRIER FUSION METHOD. Hidehiro Goto and Shigero Ikeda (Tohoku Univ., Japan). Bunseki Kagaku, 13: 16-19(Jan. 1964). (In Japanese)

An argon carrier gas fusion capillary trap condensation method was applied for the determination of oxygen in Zircaloy. The investigation was carried out mainly to determine optimum metal baths for the gas extraction. Iron was not suitable as a metal bath, as the gas could not be extracted completely in spite of the presence of a large amount of iron. A tin-iron bath containing iron as much as 20 times the sample weight gave a good result for the determination of oxygen by extracting it at 1900°C. The procedure was appreciably rapid and easily operated. When platinum was used as the bath metal, an amount only eight times as much as the sample weight was enough to obtain reproducible results. In this case, however, platinum should be added at the same time the sample is charged in the crucible and the gas extraction should be carried out at 2000°C. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**21970** DETERMINATION OF NEODYMIUM, SAMARIUM AND EUROPIUM. Takuji Komori and Shuzo Tamura (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 13: 32-8(Jan. 1964). (In Japanese)

Concentrations of neodymium, samarium, and europium in nuclear fuel materials were measured by the isotope dilution method. The electromagnetically enriched isotopes of samarium and europium ($^{147}$Sm, $^{151}$Eu) and neodymium obtained from fission products were used as spike isotopes. After dissolution of the samples, known quantities of the spike solutions were added and rare earth elements were separated from the samples by thiocyanate-tri-n-butylphosphate extraction or oxinate extraction and tri-n-butylphosphate extraction. The isotopic composition of separated rare earth elements was measured by a surface-ionization-type mass spectrometer (CEC 21-702B) without the mutual separation of rare earth elements. The concentrations of neodymium, samarium, and europium were calculated from the results of the isotopic assay. The method can be applied to the determination of some rare earth elements, such as neodymium, samarium, and europium, in the range from ppm to ppb in nuclear fuel materials with satisfactory precision and accuracy. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21971** DETERMINATION OF THORIUM IN MONAZITE BY X-RAY FLUORESCENCE. Wataru Funasaka and Teiichi Ando (Kyoto Univ.). Bunseki Kagaku, 13: 38-41(Jan. 1964). (In Japanese)

X-ray fluorescence methods were applied to the determination of Th in monazite, and the addition method combined with the internal standard method (Sr as internal standard) was found suitable. After strontium carbonate (50 mg) and thorium oxide (0, 30, or 60 mg) were added to the monazite (500 mg), the mixture was fused with potassium hydrogen sulfate (5 g). The fused matter was crushed to fine powder, and the Th and Sr intensities of the powders were measured. The content of Th in each monazite was calculated either from the ratio $I_{Th}/I_{Sr}$ or from $I_{Th}$ by applying theoretical equations. The former method gave results close to those by chemical analysis, and the latter gave a little higher results. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21972** THE DETERMINATION OF CALCIUM SALTS BY MEASURING THE INTENSITY OF REFLECTED $\beta$-RADIATION. J. Toelgyessy, M. Sarsunova, and J. Klas. Chem. Zvesti, 17: 140-5(1963). (In Czech)

$\beta$-radiation particles change their direction of flow by interaction with atoms. Backward flow is called reflected radiation. This mechanism is complicated and not fully explained; empirical knowledge allows use of it in chemical analysis. Reflection depends on atomic number of the examined material, thickness of the sample, its geometrical shape, and physical properties. The method was applied for the determination of Ca in an injection solution of Ca gluconate, $CaCl_2$ solution, and in yellow S ointment (Unguentum sulfuratum flavum). The apparatus consisted of a ring-shaped radiation source with a Pb shield and a G-M counter. $^{204}$Tl was used. A working method is described and a calibration curve is shown which was designed for the apparatus using samples of known concentration of Ca. Results obtained with the 3 chemicals mentioned were within 1%. The method gives fast results without damage to the analyzed sample. (OID)

**21973** DETERMINATION OF BERYLLIUM IN BERYL. Won-pyo Chang and Sung-keun Min. Geol. Surv. Korea, Tech. Paper, No. 3, 315-17(Dec. 1961).

A procedure for the determination of Be in beryllium aluminum silicate using EDTA as the complexant is described. A small amount of uranium and titanium always remains with the precipitate of Be even after double precipitation. (P.C.H.)

**21974** DETERMINATION OF URANIUM IN MONAZITE. Won-pyo Chang and Suck-sang You. Geol. Surv. Korea, Tech. Paper, No. 3, 328-31(Dec. 1961).

A procedure is described for the determination of uranium in monazite by the adsorption of uranium chloride complex in a strong hydrochloric acid media and subsequent sulfate complex adsorption called the double column method. (P.C.H.)

**21975** SEPARATION OF LITHIUM BY ION EXCHANGE CHROMATOGRAPHY. R. Ratner and Z. Ludmer (Technion-Israel Inst. of Tech., Haifa). Israel J. Chem., 2: 21-4(Apr. 1964).

Small amounts of lithium were separated from large amounts of sodium, potassium, calcium, and magnesium ions by a cation exchange chromatographic method. Amberlite IR-120 was used as cation exchanger and a mixture of methanol (9 volumes)-hydrochloric acid (1 volume) was employed as eluent. The separation was quantitative, lithium was eluted first and the effluents containing lithium were free from other cations. In the effluent, lithium was determined by a flame photometric procedure. (auth)

**21976** SPECTROPHOTOMETRIC STUDIES OF DIOXO-COMPLEXES OF QUADRIVALENT METALS. II. THORIUM CHELATE OF PYROGALLOLSULFONEPHTHALEIN. Kuan Pan, Zui-feng Lin, and Yu-lin Wu (National Taiwan Univ., China). J. Chinese Chem. Soc. (Taiwan), 10: 175-83 (Dec. 30, 1963).

Pyrogallolsulfonephthalein (abbreviated to PR) and its thorium chelate were spectrophotometrically studied in perchloric acid and perchlorate solution at various pH's. PR shows an absorption maximum at 478 mμ at pH 3.0, which in the presence of thorium (IV) ion shifts to 544 mμ. The optimum pH for the formation of the chelate was found to be 2.7 to 3.2 and the mole ratio of Th(IV) to PR was 1:1. The instability constant was found to be $1.40 \times 10^{-10}$ at ionic strength, $\mu = 0.01$. (auth)

**21977** DETERMINATION OF THORIA CONTENTS IN TAIWAN MONAZITE SAND AND ITS ASSOCIATED MINERALS BY GAMMA SCINTILLATION SPECTROMETRY. Yun-shu Hsing and Jing-liang Chou. J. Chinese Chem. Soc. (Taiwan), 10: 184-99(Dec. 30, 1963).

A rapid method for the determination of thoria content in Taiwan monazite sand and its associated minerals, zircon, and ilmenite, is presented. The method is gamma scintillation spectrometric, taking the area under the composite photopeak of Ra-224 (0.241 Mev) and Pb-212 (0.239 Mev) as a measure of the thoria content. It is applicable to minerals with thoria content ranging from 10 to 0.01%. The relative standard deviation is 3%. A determination can be made within one hour directly on the sample. (auth)

**21978** A SIMPLIFIED PROCEDURE FOR THE SIMULTANEOUS ASSAY OF $Fe^{55}$ AND $Fe^{59}$ IN A LIQUID SCINTILLATION SYSTEM. Jay H. Katz, Mary Zoukis, Willie Lee Hart, and Raymond J. Dern (Veterans Administration Hospital, Boston; Boston Univ.; Cook County Hospital, Chicago; and Loyola Univ., Chicago). J. Lab. Clin. Med., 63: 885-93(May 1964).

In studies of Fe metabolism it is frequently desirable to use $^{58}Fe$ and $^{59}Fe$ either simultaneously or sequentially. Satisfactory methods for assaying mixtures of these two isotopes in ionization detectors and in a liquid scintillation system were described previously, but all require special electroplating equipment not generally available. The procedure described avoids the need for this step. Iron is precipitated from the blood digests, converted to ferrous chloride in an excess of hydrochloric acid, and emulsified in a thixotropic gel. High counting efficiencies and minimal cross counting can be readily obtained, and samples are stable for at least two weeks after preparation. (auth)

**21979** DETERMINATION OF CITRIC ACID IN SERUM AND URINE USING Br-82. S. L. Jacobs (Bio-Science Labs., Los Angeles) and Norman D. Lee. J. Nucl. Med., 5: 297-301(Apr. 1964).

Radiometric assay for $^{82}Br$ was used in the analysis for citric acid by incorporation of this isotope in the brominating reagent for conversion of the citric acid to pentabromoacetone. This provided a rapid and simple means for quantitative recovery of added citric acid and a precision (95% confidence limits) of ±9.2% and ±6.6% was obtained for serum and urine specimens, respectively. Results by this technique were slightly higher for urine than those obtained by the photometric method used for comparison whereas results for serum agreed well. (auth)

**21980** NEUTRON ACTIVATION METHOD FOR THE DETERMINATION OF SODIUM IN SOME BIOLOGICAL TISSUE SAMPLES. Miloslav Rakovič and Helena Talpová (Charles Univ., Prague). Jaderna Energie, 10: 81-4(1964). (In Czech.)

The method described enables sodium to be determined in biological tissue and liquid samples weighing a few hundredths to a few tenths of a milligram of dry weight. Samples are activated in a thermal neutron flux of $1.5 \times 10^{12}$ neutrons $cm^2$ $sec^{-1}$ for 20 hours. A few hours after finishing activation the pulse count is measured directly without chemical separation and using a scintillation counter and copper filters with a total thickness of 2640 $mg/cm^2$. The method gives higher yields for some samples with higher content of potassium than sodium. (auth)

**21981** APPLICATION OF RADIOACTIVE X-RAY SOURCES IN INDUSTRIAL ABSORPTION AND FLUORESCENCE ANALYSIS. T. Florkowski (Mining and Metallurgy Academy, Krakow). Kernenergie, 7: 172-6(Mar. 1964). (In German)

Determinations, utilizing x-ray fluorescence and absorption are discussed: sulfur in hydrocarbons (absorption method), cobalt in hydrocarbons (fluorescence method), iron in lubricating oils (absorption method), lead in ores (absorption method), and zinc and iron in ores and concentrates (fluorescence method). Synthetic radioactive nuclides, such as $^{147}Pm/Al$, $^{90}Sr + {}^{90}Y/U$, and $^{3}H/Zr$, were employed as radioactive sources. (P.C.H.)

**21982** LIGNITE ASH CONTENTS MEASUREMENT BY GAMMA-RAY TRANSMISSION METHOD APPLYING $Tm^{170}$. S. Koch and R. Windelband (Technische Hochschule, Dresden). Kernenergie, 7: 176-83(Mar. 1964). (In German)

Maximum sensitivity was realized if the determination was restricted to the characteristic radiation of the $^{170}Tm$ source and the ash content was measured as a function of sample density. By decreasing the diameter of the collimator aperture and increasing the thickness of the powdered coal sample layer it was possible to increase sensitivity to a significant extent. Potential sources of error are discussed. (P.C.H.)

**21983** THE DETERMINATION OF CHROMIUM BY THE MEASUREMENT OF β-RAY REFLECTION. D. Sipos. Koloriszt. Ertesito, 5: 209-15(Aug. 1963). (In Hungarian)

Chromic oxide contents in chrome salt solutions and reduced and spent chrome liquors can be determined by the measurement of the β reflection. A short survey of the β reflection theory is given. The measuring device employed and the calibration diagrams of the various chrome liquors are discussed. A linear relationship exists between the reflection and the chrome oxide contents of the liquors. The results of measurements show that the method is well-suited for industrial and routine determination of chromic oxide contents. (auth)

**21984** QUANTITATIVE DETERMINATION OF URANIUM BY RADIOMETRY. Zoltan Pokó, Elek Szabó, and Jenő Havas. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 101-10(1964). (In Hungarian)

The principle of the radiometric method is the determination of uranium from α-measurements. For a quantitative assay, layers or surfaces of homogeneous distribution are prepared by evaporation or electrodeposition. Investigations were made of the influence of take-up agents, subsequent heating, material (aluminum, platinum, glass), and shape of evaporator pots on the process of evaporation as well as of the application technique of take-up agents. Conditions for the separation of uranium by electrodeposition on revolving cathode from solutions of its nitrate and sulfate salts were also studied. (auth)

**21985** THE DETERMINATION OF THE RESIN-TO-GLASS RATIO OF GLASS-EPOXY STRUCTURES BY BETA BACKSCATTERING. J. A. Hendron (Aerojet-General Corp., Sacramento, Calif.), K. K. Groble, and W. Wangard, II. Mater. Evaluation, 22: 213-16(May 1964).

It is shown that the beta backscatter method is capable of accuracies in determining resin-glass content of approximately ±1.5%, when measured statically. The accuracy of dynamic measurements is dependent, of course, on the necessary compromises of source size, inspection speed, etc. Measurements taken on the vessel under both dynamic and static conditions are presented, along with the results of burn tests made on plugs removed from the vessel. The readings were corrected to take into account the outside layer of pure resin. Under static conditions, the maximum error in beta gage reading (compared to burn tests) was 0.4% resin-to-glass, and under dynamic conditions, the maximum error was 0.9%. It is clearly evident that the instrument is capable of accuracies exceeding the expected ±1.5%. The repeatability of the instrument is on the order of ±0.2% (the noise factor being the statistical variations in emission), so that in the use of the instrument as a comparative device, detecting deviations from an established norm, the accuracy would be greater. (P.C.H.)

**21986** APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO STUDIES OF AGRICULTURAL DAMAGES BY WATER POLLUTION. Masao Shibuya (National Inst. of Agricultural Sciences, Tokyo) and Yuichiro Kamemoto. Mizushori Gijutsu, 4: No. 7, 17-25(July 1963). (In Japanese)

Because Cu in the wastes from mines and factories has harmful effects on the yield of agricultural products, it is important to find the Cu content of the irrigation water, the soil, and agricultural products. The application of nondestructive neutron activation analysis for the determination of Cu in the soil, soil solution, and stems of plants was studied. Studies were made on times for activation and cooling, recoveries, and sample sizes. It was found that the Cu content of the plant stems can be accurately determined when 50-100 mg of dried stem sample is irradiated for 2 hr in a nuclear reactor (TRR-1 type, $5 \times 10^{11}$ n/cm$^2$ sec), cooled for 50 hr, and its $\gamma$ spectrogram compared with the standard by using a RCL 256-channel analyzer. The Cu content of the soil and soil solution were also determined. Investigations are now being made of the Cu content of areas along the Watarase River. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21987** POTENTIOMETRIC TITRATION OF U(VI) AND U(IV) IN PHOSPHORIC ACID SOLUTION—ANALYSIS OF URANIUM OXIDES. Fumito Nakashima and Kaoru Sakai (Hitachi Ltd., Tokyo). Nippon Kagaku Zasshi, 85: 40-4 ([Jan.] 1964). [(In Japanese)]

The U(VI) can be determined by oxidimetric titration after reduction to U(IV) with Ti(III). The solution of Ti(III), prepared by dissolving metallic titanium in 85% phosphoric acid, is so stable that no special precaution is necessary for its storage. The titration was carried out in 4.4M phosphoric acid. When Ti(III) is added in excess, the potential changes from 350 to −100 mv vs S.C.E. As titrating with the standard dichromate solution, two abrupt changes of the potential were observed from −100 to 250 and from 350 to 500 mv. The first change, corresponding to the complete oxidation of excess Ti(III), becomes more pronounced if temperature of the solution is maintained at about 95°C. Passing inert gas is not necessary during the titration. It was confirmed that metallic uranium and U(IV) compounds always give U(IV) ion when dissolved in 85% phosphoric acid. The U(IV) ion can, therefore, be titrated directly with the dichromate solution, preferably at room temperature. The procedures developed are applicable to the determination of both U(VI) and U(IV) in the same sample. Several uranium octoxides and dioxides were analyzed. The sample is dissolved in 85% phosphoric acid and U(IV) is determined first by the direct oxidimetric titration. The same solution is then reduced with the addition of Ti(III) and titrated again at 95°C. The volume of the titrant delivered between two abrupt changes of the potential is a measure of total uranium present. The U(VI) content is found by the difference of total uranium and U(IV). For the determination of a few hundredth grams of uranium, the error of the method is less than 0.5%. (auth)

**21988** DETERMINATION OF TRACE AMOUNTS OF COPPER, ZINC, ARSENIC AND IRON IN SELENIUM OF HIGH PURITY BY NEUTRON ACTIVATION ANALYSIS. W. Otwinowski and Z. Allina (Inst. of General Chemistry, Warsaw). Nukleonika, 8: 833-42(1963). (In Polish)

A description is given of method for determining trace amounts of copper, zinc, arsenic, and iron in selenium of high purity by neutron activation analysis. Samples of selenium and the appropriate standards were irradiated in nuclear reactor for 20-22 hours at a flux of $10^{12}$ thermal neutrons per second per cm$^2$. Radiochemical purification of determined elements was used and the beta activity of $^{64}$Cu, $^{69m}$Zn, $^{76}$As, and $^{59}$Fe was measured. The lower limit of determination was $10^{-8}$ g Cu/g $10^{-8}$ g Zn/g, $5 \times 10^{-9}$ g As/g, and $5 \times 10^{-5}$ g Fe/g. Coefficient of variation of the mean result (based on 3 independent determinations) was not greater than 15%. (auth)

**21989** SOME PROBLEMS OF MASS SPECTROMETRY AND NUCLEAR SPECTROSCOPY. Stodzimierz Zuk (Univ. of Marie Curie Sklodowska, Lublin). Postepy Fiz., 14: 703-16(1963). (In Polish)

Some areas of research in mass spectrometry and nuclear spectroscopy that are being covered at the Marie Curie Sklodowska University are reviewed. These include: investigation of elementary ionization phenomena in gases; application of mass spectrometry to investigations of gas discharges and plasma physics; investigation of the abundance of elements and the ratios of isotopes of hydrogen, oxygen, lead, etc., in meteorites and in various regions of the earth, the hydrosphere, and the atmosphere; the application of mass spectrometry to chemistry, methods of analysis and investigation, and separation of isotopes; and research in beta and gamma spectroscopy. Methods and tools of gamma and beta spectrometry are outlined. (TTT)

**21990** ACTIVATION ANALYSIS OF FLUORINE AND BROMINE WITH 14-Mev NEUTRONS. Nobuhiko Ishibashi and Satsuo Kamata (Kyushu Univ., Japan). Radioisotopes (Tokyo), 13: 7-12(Jan. 1964). (In Japanese)

Activation analysis with 14-Mev neutrons was investigated for determination of fluorine content in its compounds and bromine content in sodium chloride. Fast neutrons were produced by the D-T reaction with the Cockcroft-Walton accelerator. Teflon (and Teflon FEP), sodium fluoride, calcium fluoride, and sodium fluorosilicate were used as fluorine samples to be analyzed, and mixtures of sodium bromide and sodium chloride as bromine samples. These samples were irradiated for 120 min (fluorine samples) or 6 min (bromine sample) on the rotating disk of 50 ~ 70 rpm. Neutron fluxes were usually about 10 n/cm$^2$ sec at sample positions. Observations of gamma rays with the 128-channel spectrometer (or single-channel spectrometer) and decay curves of the 0.51 Mev photopeak showed

that gamma rays from fluorine samples were emitted from $^{18}F$ produced by (n,2n) reaction with $^{19}F$. A large photopeak at 0.51 Mev and a small one at 0.62 Mev were observed for pure sodium bromide. The former peak was presumably emitted from $^{78}Br$ produced by (n,2n) reaction with $^{79}Br$. When a large amount of sodium chloride was mixed with sodium bromide, the decay curve of the 0.51 Mev peak tended to deviate from linearity on the usual semi-logarithmic plots. Deviation may be due to gamma rays from $^{34m}Cl$. The component of these gamma rays was subtracted from the total count by using the activity of irradiated pure sodium chloride for the analytical calculation. Fluorine and bromine contents calculated from the radioactivities of the 0.51 Mev photopeak sufficiently agreed with values from chemical analysis. Bromine in sodium chloride can be analyzed to a content of 0.8% with good accuracy. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21991** ACTIVATION ANALYSIS OF MANGANESE WITH Pu + Be 1-c NEUTRON SOURCE. Tsunenobu Shigematsu (Kyoto Univ.) and Shiro Goda. Radioisotopes (Tokyo), 13: 13-19(Jan. 1964). (In Japanese)

Radioactivation determination of Mn was studied with a low-level neutron source, 1-C Pu + Be, and the procedure designed was applied to the nondestructive determination of the element in some minerals. Paraffin was used as moderator, and the distribution of thermal neutrons was measured by using In foil, $MnO_2$, and Au foil. The maximum thermal neutron flux of $3 \times 10^3$ n/cm$^2$ sec was obtained with 1 ~ 2.1-cm thick paraffin. The self-shielding effect and self-absorption effect were also studied; both effects were observed when the amounts of sample exceeded 250 mg. A powdered sample weighing 250 mg was irradiated for 17 hr at 2.5 cm from the neutron source, and activity was measured with a G-M counter after cooling for 15 min. The decay curve and the $\gamma$ scintillation spectrum indicated that the activity obtained was due to the decay of $^{56}Mn$. Mineral constituents such as O, Na, Mg, Al, Si, Ca, and Fe gave no effect when Mn content was more than 2%. Mn in minerals can be determined within a relative error of 5%. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**21992** NEUTRON ACTIVATION ANALYSIS OF ALLOYED URANIUM COMPONENT IN CARBON STEEL. Masatoshi Kobayashi and Teruo Sawai (Tokyo Metropolitan Isotope Center). Radioisotopes (Tokyo), 13: 20-5(Jan. 1964).

The addition of a small quantity of uranium to steel has been proposed in order to improve some mechanical properties. Activation analysis of the alloyed uranium component in steel is described. Samples of commercial carbon steels containing 0.1% and 0.5% uranium were irradiated for a few minutes in a flux of $10^{11}$ n/cm$^2$ sec and allowed to stand for about 48 hr. Their radioactivities were measured directly without any chemical separation. The radionuclide used was $^{239}Np$ (half life, 2.33 days), which allows the measurement of a photoelectric peak at 0.105 Mev. The results were in good agreement with colorimetric analysis. This method was applied to the study of the segregation of uranium in two ingots. This method of activation analysis for uranium in steel offers the advantages of rapidity and simplicity in operation, and it permits the determination of the uranium content from 1% to 0.0001%. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21993** DETERMINATION OF TRACE ELEMENTS IN ALUMINIUM BY NEUTRON ACTIVATION. Masatoshi Kobayashi and Sumiko Nagatsuka (Tokyo Metropolitan Isotope Center). Radioisotopes (Tokyo), 13: 26-31(Jan. 1964).

A simple separation scheme was investigated for the systematic determination of the radioactive nuclides produced from impurities contained in Al of high purity. The radionuclides were divided into two groups according to their half lives. Impurities such as Cu, Sb, As, and Ga, which give rise to radioactivities with comparatively short half lives, are separated by precipitation. Impurities such as Sc, Fe, Zn, and Cd, which give rise to long-lived $\gamma$ activities, are separated by anion exchange. The separated fractions are then analyzed by $\gamma$ spectrometry. This separation scheme permits determination of Cu ($2 \times 10^{-6}$ g), Sb ($5 \times 10^{-7}$ g), As ($8 \times 10^{-6}$ g), Ga ($3 \times 10^{-7}$ g), Sc ($6 \times 10^{-6}$ g), Fe ($4 \times 10^{-5}$ g), Zn ($9 \times 10^{-6}$ g), and Cd ($7 \times 10^{-6}$ g). The time needed was about 5 hr respectively for the precipitation method and for the anion exchange method. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21994** THE DETERMINATION OF MICRONUTRIENT ELEMENTS IN SOIL BY RADIOACTIVATION ANALYSIS. Yoshio Yamada (Kyushu Univ., Japan). Radioisotopes (Tokyo), 13: 32-8(Jan. 1964). (In Japanese)

Radioactivation analysis is very useful for the determination of micronutrient elements in soil. The details of the methods are described for Ni, Cu, Zn, Mo, and Co in soil. Soil samples and standard samples, which contained known amounts of the elements, were activated simultaneously for 14 hr in the pile ($1.5 \times 10^{12}$ n/cm$^2$ sec), and systematic radiochemical separation of the individual elements followed using carriers. Finally, these elements were precipitated as Ni-dimethylglyoxime, Cu-thiocyanate, Zn-quinaldate, Mo-hydroxyquinolate, and potassium cobaltinitrite. Radiochemical purity of each compound was confirmed by plotting decay curves and gamma spectrometry. The radioactivities due to these elements from the soil samples and standard samples were compared after correction for chemical yields, self-absorption, radioactive decay, and paralysis time. The quantities of these elements were calculated by beta counts and gamma counts, respectively. The results for the soils treated or nontreated with farmyard manure for many years showed that the farmyard manure had small increasing effects on the contents of the micronutrient elements in soil. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**21995** PRECIPITATION FROM MIXED SOLVENTS. V. URANIUM 8-HYDROXYQUINOLATE. Lester C. Howick and Tony Rihs (Univ. of Arkansas, Fayetteville.) Talanta, 11: 667-9(Apr. 1964).

The technique of precipitation from homogeneous solutions of mixed solvents was applied to the case of uranium 8-hydroxyquinolate. Precipitation from a water-acetone solution results in the formation of well-defined crystals of high purity. The separation of uranium from magnesium is easily accomplished and separations from thorium and lead may be achieved in the presence of EDTA. (auth)

**21996** ISOTOPIC-DILUTION ANALYSIS BY ION EXCHANGE. II. SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF INDIUM. Jaromír Růžička and Jiří Starý (Faculty of Technical and Nuclear Physics, Prague). Talanta, 11: 691-6(Apr. 1964).

A highly selective, substoichiometric method for determination of traces of indium was developed. The procedure consists of the addition of a substoichiometric amount of EDTA to the test solution labeled with a known amount of radioindium, followed by the separation of the complex formed from the excess of unreacted indium on a Dowex-50 column. Using a preliminary cupferron extraction, the procedure becomes highly selective. The average precision

of the determination of indium for amounts of 1.1 μg/10 ml is 1.6% in the presence of an excess of many metals. The maximum sensitivity of the method is about $5 \times 10^{-5}$ μg/10 ml. (auth)

**21997** SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF METALS. Jiří Starý and Jaromír Růžička (Faculty of Technical and Nuclear Physics, Prague). Talanta, 11: 697-702(Apr. 1964).

The possibilities of substoichiometric determination of traces of metals by activation analysis and isotope-dilution analysis are critically discussed and optimum conditions given for the determination of 24 metals. (auth)

**21998** THE PRESENT STATUS OF X-RAY SPECTROMETRY IN THE CLINICAL LABORATORY. Samuel Natelson (Roosevelt Hospital, New York). Trans. N. Y. Acad. Sci., 26: 3-26(Nov. 1963).

The principles, techniques, apparatus, and medical applications of x-ray spectrometry are discussed. A source of excitation, such as a beam of x rays or an electron beam, is allowed to impinge on the sample. The reflected beam now comprising the mixture of lines from the excitation source is collimated so that parallel rays strike the analyzing crystal. The lines are now resolved so that they can be detected individually after passing through a second collimator. The collimator usually comprises a series of parallel nickel plates of from 5 to 40 mil apart, depending upon the element sought and the resolution required. The detector is a counting device such as a Geiger-Müller, flow-proportional, proportional, or scintillation counter. The signal from the counter can be evaluated by counting or taking the time required for readout of a fixed number of counts. Further, the emission can be visualized on a recorder or recorded on a printout device. For qualitative purposes, a scan may be taken to obtain either a spectrum of a particular element or a semiquantitative measure of the elementary composition of the substance. The instrumentation is described in detail and illustrated, and the construction of a new sample compartment for holding 10 specimens is explained. An automatic sample changer was devised, by modification of a 35-mm slide changer, which speeds up analysis of specimens. The technique is more readily applied to the assay of the lighter elements. For example, for Pb it is possible to obtain only 15 cps/μg, but under the proper conditions, as high as 350 cps/μg for K and Ca. Thus, tests for Ca and K, Cl and S, and P can be performed directly on a minute quantity of human serum. In silicosis, lung-tissue Si can be assayed directly. Aluminum is assayed also in microgram quantities. However, as the wavelengths become longer, the emission from the sample is more readily absorbed by air and other materials. Sodium assay is presently impractical, but under special conditions, Na and elements down to Be were detected. Another application of the instrument is for scanning of electrophoretic strips for the S content of particular proteins. The unstained electrophoretic strips are passed through the x-ray field while the instrument is set at the peak of the sulfur $K_\alpha$ line with the NaCl crystal and the Cr target tube. Subsequently the strips are stained for scanning by a densitometer. Under the proper conditions, the distribution of Fe and Cu in human serum proteins can also be detected. The location of the phospholipids by the P content can be scanned in a like manner. For rapid automation, the specimen may be inserted in the field and removed automatically. Thus an analysis is available every 20 sec or at the rate of 180/hr. At the same time, by the use of several detectors suitably placed around the field, several elements can be simultaneously detected. An instrument is available that reads eight elements on each specimen by feeding the results sequentially to a rapid printout device that prints the results sequentially. Possible clinical applications of some other recently developed instruments, such as the electron probe, are also considered. In the electron probe, the electron-microscope beam of electrons impinges on the specimen and the x-ray emission from the sample is assayed, as described above for x-ray spectrometry. The instrument permits examination of minute areas for element composition, but is destructive of tissue. Of even greater interest to the clinical chemist is the recent development of an x-ray source using radioactive emission impinging on a suitable target to generate the activating x-ray beam. (BBB)

## Inorganic and Physical Chemistry

**21999** (AERE-R-4517) SOME EXPERIMENTAL STUDIES OF ELECTRODEIONISATION THROUGH RESIN PACKED BEDS. G. J. Gittens and R. E. Watts (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1964. 53p.

The electrodeionization of solutions of sodium nitrate was studied using five compartment cells. The effect of the solution concentration, current density, solution flow rate, cell width, and type of resin filling was investigated. The results may be expressed in terms of a theoretical model, which accounts for the observed differences between cation and mixed bed fillings. The work goes a step further in understanding the basic principles of electrodeionization and the interrelation of the parameters of practical interest. (auth)

**22000** (AROD-3006:6) DETERMINATION OF HYPERFINE INTERACTIONS IN SOLIDS BY THE USE OF RADIOACTIVE NUCLEI. Final Report. M. E. Caspari and S. Frankel (Pennsylvania. Univ., Philadelphia). Apr. 15, 1964. 5p.

The status of measurements of the magnetic hyperfine interaction and electronic relaxation time as well as the g-factors of excited states in rare earth ions in garnets and metallic compounds is reported. The measurements are being made by gamma-gamma angular correlation techniques. (D.C.W.)

**22001** (BNL-7784) THE BEHAVIOR OF IODINE IN GRAPHITE. F. J. Salzano (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 32p. (CONF-73-23)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

The adsorption of iodine on National Carbon type TSX graphite was studied at 100, 200, 500, and 800°C, over the pressure range 0.01 to 15 mm Hg, using a tracer technique. Above 200°C iodine was chemisorbed on a small fraction of the graphite surface. At 100°C the iodine was held on the graphite by both chemisorption and physical adsorption. The surface area of the graphite, determined from the 100°C iodine adsorption isotherm using the B.E.T. theory, was found to be in good agreement with surface values obtained from nitrogen isotherms at −195°C. No relation was found between the amounts of iodine adsorbed on various samples and their surface area, at concentrations below one monolayer. The adsorption of iodine was enhanced by high-temperature outgassing (2000°C) and contact with water vapor at 900°C. A small fraction of

the iodine adsorbed at 25 and 100°C could not be removed from the graphite by heating in vacuo at 950°C. The amount of iodine irreversibly adsorbed at 25°C, in saturated iodine vapor, was approximately proportional to the reversible iodine adsorption at higher temperatures. (auth)

**22002** (CONF-209-26) SORPTION MEASUREMENTS IN ULTRAHIGH VACUUM AT CONSTANT PRESSURE. Richard Gibson, B. Bergsnov-Hansen, Noboru Endow, and R. A. Pasternak (Stanford Research Inst., Menlo Park, Calif.). [1963]. Contracts AT(04-3)-115 and AT(04-3)-425. 16p.

From the American Vacuum Society Meeting, Boston, Oct. 1963.

A new flow system in which the sample is exposed to constant pressure was used for the study of adsorption and absorption of gases by filaments and evaporated films. The design of the flow system is described. Results with nitrogen on niobium filament and molybdenum film are given. Nitrogen sorption by a niobium filament was found to depend strongly on temperature. Sorption rates measured at lower temperatures decline strongly with time, but above about 500°C there is little time dependence. Nitrogen sorption on molybdenum was found to be independent of pressure. Graphs on sticking probability are given. (P.C.H.)

**22003** (CONF-499-1) A STUDY OF CARBON–OXYGEN SURFACE COMPLEXES USING $O^{18}$ AS A TRACER. F. J. Vastola, P. J. Hart, and P. L. Walker, Jr. (Pennsylvania State Univ., University Park). [1963]. Contract AT(30-1)-1710. 18p.

From American Chemical Society 141st National Meeting, Washington, D. C., Mar. 1962.

Upon the reaction of carbon with $O_2$, three products form: CO, $CO_2$, and a carbon-oxygen surface complex. The CO and $CO_2$ are produced through two paths: (1) via a fleeting oxygen surface intermediate and (2) via the breakdown of an oxygen surface complex. $^{16-16}O_2$ and $^{18-18}O_2$ were used in this study to ascertain the extent to which the breakdown of the surface complex contributes to the formation of CO and $CO_2$ during the combustion of Graphon at temperatures between 505 and 555°C. The rate of complex breakdown to CO and $CO_2$ is a function of the total rate of carbon gasification, the fraction of active surface area covered with complex, and the reaction temperature through a participation factor. The fraction of the total CO and $CO_2$ produced which is contributed by complex breakdown decreases with increasing combustion temperature. In a complementary study, again using $^{16-16}O_2$ and $^{18-18}O_2$, it was shown that the ease of oxygen complex desorption from the surface of Graphon is independent of its time of formation. (auth)

**22004** (DP-871) STABILITY OF FERROUS SULFAMATE IN NITRIC ACID SOLUTIONS. E. Kenneth Dukes and Richard M. Wallace (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Feb. 1964. Contract AT(07-2)-1. 7p.

The rates of oxidation of ferrous ion in solutions of sulfamic acid and 5.0 to 7.0M $HNO_3$ were measured at temperatures of 23 to 55°C. From these rates, an expression, $\log k = 4.56 \log [HNO_3] - 5140(1/T°K) + 10.4$, was derived for calculating the rate of oxidation of ferrous ion under these conditions. (auth)

**22005** (DRI-2156) A STUDY OF THE SYNTHESIS AND PROPERTIES OF TRANSITION METAL HYDRYLS. Quarterly Progress Report No. 7, January 1–March 31, 1964. Charles B. Magee (Denver. Univ. Denver Research Inst.). Apr. 16, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1185. 16p. (EURAEC-1029)

An experiment was completed in which hydrogen was added to the compound LiIr at 700°C. The equilibrium hydrogen pressure versus gram-atom fraction hydrogen in the condensed phase, $N_H$, curve shows a single broad plateau implying that four phases are in equilibrium. These phases are assumed to be $H_2$ gas, $(LiH)_4Ir$, LiIr, and Ir. This pressure isotherm is quite different from the isotherm for the Li–Rh–H system determined under the same conditions. Attempts to form LiCo by the direct combination of the elements have continued, but none has proved successful. Some attempts to prepare $Co(LiH)_4$ were made, and these too were unsuccessful in that complete reaction was not effected. Experiments along this line are continuing. An x-ray diffraction pattern of $(LiH)_4Th$ was partially indexed. The crystal structure appears to be tetragonal with $a_0 = 11.188 \pm 0.008$ Å and $c_0 = 8.918 \pm 0.007$ Å. Assuming a density of 4 g/cc, the unit cell of this crystal would contain 20 moles of $(LiH)_4Rh$. Investigations of the reaction between hydrogen and $(LiH)_4Rh$ to form $(LiH)_4RhH$ have failed to show a plateau equilibrium pressure of hydrogen. This is interpreted to mean that there is no phase change in either the solid or liquid when $(LiH)_4RhH$ is formed from $(LiH)_4Rh$. (auth)

**22006** (HW-SA-3460) TECHNETIUM-99. E. D. Sayre (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 3, 1964. Contract [AT(45-1)-1350]. 7p.

The chemistry of technetium is discussed and its properties described. $^{99}Tc$ is a weak beta emitter with a $2.1 \times 10^5$ year half life. The abundance and cost of technetium is reported. (M.C.G.)

**22007** (KY-452) INVESTIGATIONS OF CARBON-TO-CARBON-CONNECTED ANODE ASSEMBLIES IN FLUORINE GENERATORS. W. B. Goode, Jr., C. R. King, W. K. Henderson, and S. Bernstein (Paducah Gaseous Diffusion Plant, Ky.). Apr. 10, 1964. Contract W-7405-eng-26. 42p.

Medium temperature fluorine cells are utilized in connection with the production of uranium hexafluoride. The carbon anodes of these cells are mechanically connected to a metallic anode support bar within the cell. Corrosive attack of the anode connection is the most common cause of cell failure. Accordingly, extensive tests were conducted in an effort to improve the durability of the internal anode connection. These tests enabled improvements to be made in fluorine cell service lives through proper utilization of the data collected. An unsuccessful attempt to obtain further improvements in cell lives by utilizing carbon to carbon anode connections is described. Two basic faults appear to have contributed to the rapid failure of cells tested, based on an evaluation of the operating experience obtained from three laboratory test cells and two plant test cells. First, all of the carbon anode assemblies tested had inherent mechanical weaknesses. The most obvious fault was that the designs were found to depend too heavily upon the tensile strength of carbon, a material which has relatively poor tensile strength. A second major fault was evidenced by rapid deterioration of the carbon to carbon electrical connections, due to the exposure of these critical areas to direct fluorine contact. (auth)

**22008** (NP-13888) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF GASES

AND GAS-CONDENSED PHASE REACTIONS. Number 9. L. Brewer, comp. (California. Univ., Berkeley). Sept. 30, 1963. 15p.

References (128) on reactions between gases and condensed phases and spectroscopy of interest to high-temperature chemistry are given to theses, reports, and U. S. and foreign journals published from 1960 through 1963. (P.C.H.)

**22009** (NP-13889) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. Volume 1963, Number 4. [Period Covered]: October–December 1963. J. J. Diamond, ed. (National Bureau of Standards, Washington, D. C.). 48p.

References (489) on devices for achieving, measuring, and controlling temperatures above 1000 and 1500°C, properties of materials below and above 1000°C, phase equilibria, and reactions at temperatures above 1000°C are given to theses and U. S. and foreign journals published during 1963. (P.C.H.)

**22010** (ORNL-3591(p.3-15)) HIGH-TEMPERATURE PHASE EQUILIBRIUM STUDIES. (Oak Ridge National Lab., Tenn.).

Investigations of high-temperature phase equilibria were continued for systems having potential use in molten-salt-reactor technology. Much of the phase diagram for the MSRE solvent system, $LiF-BeF_2-ZrF_4$, was described in detail. Investigation of the complex equilibria in the system $LiF-NaF-ZrF_4$ was completed upon determination of crystallization behavior of the ternary compound $LiF \cdot NaF \cdot ZrF_4$. The hypothesis that some ten of the sodium fluoride–rare-earth trifluoride systems would approximate the model system $NaF-YF_3$ in crystallization behavior was tested and corroborated. An investigation of the system $KCl-UCl_3$ was initiated as part of an effort to evaluate molten chlorides as fast reactor fuels. Optical and x-ray crystallographic data were obtained for a number of compounds, primarily complex fluorides. A determination of the crystal structure of $6LiF \cdot BeF_2 \cdot ZrF_4$ established the existence of separate $BeF_4^{2-}$ and $ZrF_8^{4-}$ ions in this solid phase. The compound $XeF_2 \cdot XeF_4$ was isolated and was shown by x-ray diffraction studies to contain discrete $XeF_2$ and $XeF_4$ molecules in the crystal. Refinement of the crystal structure of $Cr_2F_5$ was completed, and the ligand-field distortions caused by its ions were characterized. (auth)

**22011** (ORNL-3591(p.38-58)) CHEMICAL STUDIES IN MOLTEN SALTS. (Oak Ridge National Lab., Tenn.).

Observations with sessile drops for the purpose of studying wetting behavior implied that molten fluorides penetrate graphite by capillarity only when the surface tension of the liquid is less than some critical value, which may be as high as 180 dynes/cm. Conversely, melts with high surface tensions, like those for use in the Molten Salt Reactor Experiment, wetted neither graphite nor metal. The role of oxide at the liquid-solid interface in causing decreasing contact angles was demonstrated. Moisture removal from specimens of MSRE graphite was tested under conditions simulating those expected prior to MSRE startup. Very little water was released from the graphite; exposure to moist environments did not cause any water adsorption, and even prior immersion of the specimen in liquid water was ultimately followed by the release of only a very small amount of chemisorbed water. The results of the tests indicated that water contamination from the MSRE graphite will not be serious. Continuing studies of $UO_2$ and $ZrO_2$ behavior in equilibrium with melts simulating mixtures of MSRE fuel salt and flush salt provided additional evidence that no appreciable formation of $(U-Zr)O_2$ solid solution occurs in the range of 500 to 700°C. The equilibrium ratio of $[Zr^{4+}]/[U^{4+}]$ in the melt, above which $UO_2$ was found to dissolve and $ZrO_2$ was found to precipitate as the only stable oxide phase, was measured in this temperature range as a function of $Zr^{4+}$ concentration in the melt. While there was an increasing temperature dependence at low $U^{4+}$ and $Zr^{4+}$ concentrations, this critical ratio was below the $[Zr^{4+}]/[U^{4+}]$ ratios expected in fuel salt, and in its mixtures with flush salt; that is, a sufficient margin of protection against $UO_2$ precipitation appears to be afforded by the previously specified $ZrF_4$ concentration in the MSRE fuel salt. The equilibrium behavior of the reaction of HF and $H_2O$ with molten $2LiF \cdot BeF_2$ containing oxides was examined as a means to study further the chemistry of such melts. The equilibration of a stream of $H_2$ containing small concentrations of HF and $H_2O$ with $2LiF \cdot BeF_2$ solutions was found to be rapid and measurable. Using melts saturated with BeO, the resulting $P_{HF}^2/P_{H_2O}$ quotient, in combination with literature data for the same reaction involving pure $BeF_2$, gave $\gamma_{BeF_2}$ values of 0.16 to 0.4 in the range of 500 to 700°C. Results for melts saturated with $ZrO_2$, combined with thermochemical data, gave $\gamma_{ZrF_4}$ values of ~0.02. Similar results and calculation gave $\gamma_{UF_4}$ values of the same order of magnitude. These were crude estimates of $\gamma_{ZrF_4}$ and $\gamma_{UF_4}$, however, owing to uncertainties in the thermochemical data. Equilibrium data in the literature for the hydrofluorination of $UO_2$ to $UF_4$, in combination with the present results, suggested that these $\gamma$ values are actually near unity. The observed $P_{HF}^2/P_{H_2O}$ quotients (in atmospheres) in equilibrium with $ZrO_2$-saturated melts, combined with a previous estimate of the solubility product of $ZrO_2$, yielded the expression $[O^{2-}] = 5 \times 10^{-4}\ (P_{H_2O}/P_{HF}^2)$ moles/kg, relating observed equilibrium $P_{H_2O}/P_{HF}^2$ quotients to the oxide ion concentration of dilute $2LiF \cdot BeF_2$ melts at 600°C. Measurements of the total uranium concentration and the reducing power in molten $LiF-BeF_2-ZrF_4$ systems saturated with $UF_3$ under reducing conditions were interpreted to give maximum values for $UF_3$ solubility in MSRE fuel mixtures at temperatures from 550 to 700°C. The values were somewhat below those expected by analogy with reported results for the solubility of $PuF_3$ and $CeF_3$ in fluoride melts. Measurements of the viscosities of molten fluoride mixtures were made with the use of a rotating-spindle viscometer over the range of 475 to 830°C. Compositions representing the MSRE fuel and coolant mixtures were measured at temperatures between 475 and 600°C and found to have viscosities between 9 and 25 centipoises. The effect of additions of LiF (up to 6.7 mole %) on the viscosity of $LiF-BeF_2$ mixtures was determined in the range of 525 to 840°C and found to be quite large; decreases in viscosity of up to two orders of magnitude were noted at 700°C. Electroanalytical methods for molten $LiF-BeF_2$ solutions are being examined as an approach to the analysis of MSRE fuel salt for corrosion-product metal ions, oxide ion, U(IV), and Zr(IV). Stationary electrodes of pyrolytic graphite and platinum were used, with hot-pressed boron nitride for electrical insulation. Stationary-electrode polarography gave the expected current peaks, proportional to concentration, in the reduction of Fe(II), although the precision was not good (~13%). Anodic-stripping voltammetry was found to give good precision for both Fe(II) and Ni(II), 3.5 and 1%, respectively. Chloride salt systems, which were studied, promise to facilitate the prompt separation of protactinium from irradiated thorium, by a volatilization technique, with the possibility of producing $^{233}U$ of high isotopic purity. Phase equilibria in the $AlCl_3-ThCl_4$, $AlCl_3-ZrCl_4$, and $ThCl_4-ZrCl_4$ systems were studied. The solubility of $ThCl_4$

in $AlCl_3$ was indicated to be substantially below 10 mole %. A simple eutectic was indicated in the $AlCl_3-ZrCl_4$ system. Although the literature implies a two-liquid-phase region at intermediate compositions, this was not found. Appreciable supercooling was observed, however. A brief examination of the $ThCl_4-ZrCl_4$ system indicated little mutual solubility. It was previously speculated that the inclusion of $ZrCl_4$ might enhance the solubility of $ThCl_4$ in $AlCl_3$. (auth)

**22012** (ORNL-3591(p.67-9)) CHEMISTRY OF PRESSURIZED-WATER REACTOR SYSTEMS. F. H. Sweeton, C. F. Baes, Jr., R. W. Ray, and T. H. Handley (Oak Ridge National Lab., Tenn.).

In a continuing study of the chemical behavior of the water in the pressurized-water loop of the Oak Ridge Research Reactor, use of a side-stream sampling system which permits the analysis of much larger volumes of water than previously possible confirmed previous estimates of the low level of water-borne corrosion products and activity. In addition, determination of specific activities, based on the measurable amounts of the parent nuclides removed from these large volumes of water, is now possible. The initial results showed that a burst of active solids at loop startup contained iron of long activation time and was presumably released from in-flux walls. Also present was chromium of short activation time, which presumably was released from out-of-flux walls. Subsequent samples showed decreased specific activities of iron, suggesting that the principal source was out-of-flux deposits. A 260°C test of magnetite ($Fe_3O_4$) as an adsorbent of soluble iron in loop water showed that all the iron was adsorbed by the $Fe_3O_4$. The amount of iron involved was very large (equivalent to 1 atom per $A^2$), which suggests that the adsorbed iron penetrated the $Fe_3O_4$ lattice. In the same test no appreciable cobalt got by the $Fe_3O_4$, although only 20% was actually found on the $Fe_3O_4$. In laboratory tests, a measurement of the solubility of magnetite indicated a value of $4-9\times10^{-8}$ M in water which had a room temperature pH of 4.6 to 4.8. (auth)

**22013** (ORNL-3591(p.70-6)) CHEMICAL SUPPORT FOR HIGH-FLUX REACTORS. (Oak Ridge National Lab., Tenn.).

The three-year-old program on corrosion of aluminum fuel cladding and the effect of adherent corrosion products on heat transfer in the Advanced Test Reactor and in the High Flux Isotope Reactor was completed. Aluminum alloy 6061 promises adequate corrosion resistance as cladding material for the relatively short-lived fuel elements in both reactors, provided the pH of the cooling water is maintained at 5.0 with nitric acid. Even with this precaution the low thermal conductivity of the adherent corrosion product ($Al_2O_3$) causes fuel plate temperatures so high as to make careful design of the fuel elements essential. Evaluation of materials for use in more permanent regions of the High Flux Isotope Reactor was continued. Coupling of stainless steel to 6061 aluminum caused pitting of the aluminum in the contact or crevice area; pitting was more severe with martensitic than with austenitic stainless steels. As a result of these tests, the aluminum sections will be thickened to allow for the anticipated corrosion. Type 6061 aluminum exposed freely to water with a pH of 5.0 at 100°C showed negligible corrosion, even at flow rates as high as 30 fps. Although QMV beryllium corroded at about 2 mils/yr and showed a tendency to pit, the beryllium reflector should last its design lifetime. Type 420 stainless steel was subject to cracking and appeared unusable in the reactor. Estimates were made of the radiolytic decomposition of water and the changes in hydrogen ion concentration, which might occur in the primary coolant of the High Flux Isotope Reactor under several possible operating conditions. The expected steady-state concentrations of $H_2$, $H_2O_2$, and $O_2$ are in the neighborhood of $10^{-4}$ to $10^{-3}$ M, depending on the concentration of excess oxidant and on temperature and power density. It is possible that $HO_2$ may provide the desired hydrogen ion concentration of $10^{-5}$ M. It is likely that conditions can be maintained in the HFIR under which little or no change in $HNO_3$ concentration will occur. Additional experiments in the ETR would provide a firmer basis for estimating $HNO_3$ stability in the HFIR, and the feasibility of making such tests is being explored. (auth)

**22014** (ORNL-3591(p.84-101)) PHYSICAL CHEMISTRY OF HIGH-TEMPERATURE AQUEOUS SYSTEMS. (Oak Ridge National Lab., Tenn.).

Electrical conductances of $K_2SO_4$ and $KHSO_4$ solutions (in $H_2O$) were measured at temperatures from 0 to 800°C and at pressures from 1 to 4000 bars. By means of the Fuoss-Onsager conductance equation, $\Lambda = \Lambda_0 - Sc^{1/2} +$ Ec log c + Jc, values of $\Lambda_0$ for $K_2SO_4$ were obtained. At each of several high temperatures the Walden product (viscosity times equivalent conductance) for $K_2SO_4$ solutions was found to be nearly constant at densities varying from 1.0 to 0.5 g/cm$^3$. From the measurements on both $KHSO_4$ and $K_2SO_4$ solutions, the dissociation constant of the bisulfate ion was calculated at 100, 200, and 300°C, at several densities. Above 300°C the constant became too small (less than $10^{-5}$) to be evaluated. By means of an optical cell, the effects of pressure on liquid-liquid immiscibility for $UO_2SO_4-H_2O$ solutions from 0.28 to 4.53M were extended to 1700 bars at temperatures up to 400°C. All curves of temperature vs pressure were linear to the highest pressure, each having a slope, $\Delta t/\Delta p$, of approximately +0.075°C/bar. Temperatures between 300 and 410°C for the appearances of critical phenomena (where liquid ≡ vapor) and liquid-liquid immiscibility were determined in the condensed system $UO_3-Li_2O-SO_3-D_2O$ at concentrations of $SO_3$ from 0.05 to 1.0 M. Based on these and previous data, isotherms were drawn to describe boundary limits of liquid-liquid immiscibility, critical phenomena, and appearance of solids in this system. A double oxide of $UO_3$ and NiO was synthesized at 300°C in the systems $UO_3-NiO-SO_3-N_2O$ and $UO_3-NiO-N_2O_5-H_2O$. The new compound, $NiO\cdot3UO_3$, was observed to be thermally stable to somewhat above 900°C. Computer methods for the reduction of data from potentiometric measurements of cation hydrolysis to hydroxyl numbers as a function of pH were developed. These computations permit consistency tests of the data, which may lead to correction of small errors in the concentrations and which verify the manner in which liquid-junction potentials are treated. The study of $Th^{4+}$ hydrolysis was extended down to 0°C to aid in the identification of the hydrolysis mechanism. Comparison of the previously reported results at 95°C with a number of possible mechanisms indicated one scheme of three hydrolysis products and three schemes of four hydrolysis products, which are consistent with the data. Similar tests of the data at 25 and 0°C, in progress, may indicate which is correct. A study of the hydrolysis of $Fe^{2+}$ at temperatures up to 200°C was begun. The preliminary results at 95, 150, and 200°C indicated, as was observed at 25°C, that the principal species formed is $FeOH^+$ and that hydrolytic precipitation greatly limits the range of hydroxyl numbers which can be studied. The tendency of this ion to hydrolyze increased rapidly with temperature; the formation quotients of $FeOH^+$ were estimated to be $10^{-7.5}$, $10^{-6.3}$, and $10^{-5.9}$ at 95, 150, and 200°C, respectively. Isopiestic ra-

tios with reference to NaCl solutions were determined at 152°C for the chlorides of lithium, potassium, and cesium, and barium and the sulfates of sodium and magnesium at concentrations above 0.75M. Osmotic coefficients were calculated with the aid of recently published high-temperature vapor pressure data for NaCl. Osmotic coefficients at 152° went through a maximum with increasing concentration, in contrast to the normal monotonic increase at 25°. Lithium chloride behaved as other alkali halides, rather than displaying the anomalous behavior observed at 25°C. (auth)

**22015** (ORNL-3591(p.102-12)) INTERACTION OF WATER WITH PARTICULATE SOLIDS. (Oak Ridge National Lab., Tenn.).

A series of experiments on heats of immersion of thorium dioxide in water at 25°C disclosed no measurable effect by organic vapor contaminants in the vacuum outgassing system and no measurable effect of prewetting the sample (before outgassing) with either water or concentrated ammonium hydroxide. Mild mechanical agitation of agglomerated thoria reduced the material to a very fine powder, but produced only minor changes in surface area or in total heat of immersion. However, the "slow" portion of the heat of immersion observed with the original material was eliminated. The determination of an adsorption isotherm for water on thoria yielded a typical type II isotherm showing multilayer adsorption involving both chemical and physical adsorption. Heats of immersion depend markedly on the amount of presorbed water. The heat at completion of a monolayer was only 27% of that for samples with no presorbed water. A sensitive microbalance was incorporated into a gravimetric adsorption apparatus for precise study of adsorption and desorption phenomena, as well as for the preparation of samples for calorimetric study. The balance was found to be subject to a thermomolecular flow error in a rather specific pressure range. Detailed study of this phenomenon indicated that the error introduced may be minimized, but not eliminated, by careful attention to several experimental details. Determination of the electrical resistance of water and dilute KCl solutions in a ceramic thoria capillary disclosed systematic and reproducible effects of the flow of liquid through the capillary. Vibratory compaction of oxide fuel congeries was found to be an attractive technique for fabricating thorium-based fuel rods. The reported failure of similar fuel compacts through inleakage of water during reactor shutdown and subsequent bursting of the fuel rod on reactor startup led to a study of the permeability of Kilorod fuel and the relationship of this permeability to water-logging failure. Data from scouting experiments indicated that a combination of electro-osmotic forces and transport of fines within typical fuel compacts studied would present a problem under reactor operating conditions. The measured permeabilities fell in an intermediate range, which allows water-logging through a cladding defect at zero or low power, but allows such slow egress of water upon a sudden rise in fuel element temperature that catastrophic element failure could occur from internal pressure. (auth)

**22016** (ORNL-3591(p.115-23)) DIFFUSION PROCESSES. (Oak Ridge National Lab., Tenn.).

Thermal transpiration data on argon with Pyrex glass capillaries under several different temperatures can be described by expressions derived on the basis of the "dusty gas" model, a model which considers gas migration in porous media as a transport through localized, uniform agglomerations of giant pseudo-gas molecules. Recently published data at extremely low pressures showed considerable deviations from theory, but were since explained in terms of the dusty gas model by postulating an accommodation effect. A prototype gaseous diffusion apparatus was constructed to investigate intermolecular interactions. Experiments with the gas pair He–Ar over the range of 0 to 120°C, conducted for purposes of calibration, are nearing completion. The results obtained indicated that values of the diffusion coefficient, over the temperature range cited, can be determined with a precision of at least ±3%. The classical trace-layer technique was employed to determine diffusion coefficients for uranium, protactinium, and thorium in a pyrolytic carbon and porous graphite at temperatures ranging from 1400 to 2300°C. It was found that the diffusion behaviors of the actinides studied were similar. The ratio of diffusion coefficients in a direction parallel to the basal planes of the pyrolytic carbon to those in the perpendicular direction was 380; the associated activation energy, applicable to both directions, was 60.8 kcal/mole. Values of the coefficients ranged from $10^{-7}$ to $10^{-12}$ $cm^2/sec$. Results for a porous graphite fell in between the two sets of values obtained for pyrolytic carbon, with approximately the same activation energy. Studies of self-diffusion of beryllium in beryllium oxide were continued. Experiments with unirradiated, high-density (97% of theoretical) polycrystalline BeO over the range 1100 to 1800°C were concluded. Self-diffusion coefficients in the unirradiated specimens may be summarized by the equation $D = 2.49 \times 10^{-3} \exp(-62.5 \times 10^3/RT)$ $cm^2/sec$. A diffusion model based on vacancy migration was proposed. The model predicts identical activation energies for diffusion in both a and c directions in single crystals and predicts an activation energy of the correct order of magnitude. The model also predicts that the frequency factor in the direction perpendicular to the c axis is about 50% higher than that in the direction parallel to the c axis. In-pile measurements of self-diffusion at 700°C during irradiation suggest an enhancement of 3 orders of magnitude in the diffusion coefficient for a flux of approximately $10^{13}$ nv (>1 Mev). Measurements on specimens which were previously irradiated to $5.7 \times 10^{19}$ nvt (>1 Mev) indicated a significant decrease in activation energy and an increase in diffusion rates. Corresponding measurements on specimens irradiated to only $2 \times 10^{19}$ nvt did not show significant changes from the results obtained with the unirradiated specimens. Measurements on unirradiated specimens of lower densities (77.2, 82.5, and 90.2% of theoretical) indicated that diffusion is greatly enhanced with lower densities. (auth)

**22017** (ORNL-3591(p.124-7)) REACTIVITY OF GRAPHITE AND OF FUELED GRAPHITE SPHERES WITH OXIDIZING GASES. L. G. Overholser (Oak Ridge National Lab., Tenn.).

A 1-in.-dia sphere of Speer Mod-2 graphite was reacted with He–$CO_2$ and He–$H_2O$ mixtures. The apparent order of the reaction at 975°C was found to be ~0.7 for both $CO_2$ at 300 to 1650 vpm (parts per million by volume) and $H_2O$ from 100 to 760 vpm. The data suggest that the apparent order of both reactions increases at lower concentrations. Activation energies measured at 110 and 460 vpm of $H_2O$ were found to decrease from ~58 to ~40 kcal/mole as the temperature was increased from 825 to 1025°C. Hydrogen additions retarded the $H_2O$-graphite reaction. Various lots of fueled graphite spheres were exposed to a partial pressure of steam of ~730 mm Hg at 800 to 1000°C. The rate of reaction of the fuel body with steam, the rate of production of hydrogen, and the $CO/CO_2$ ratio in the effluent gases were determined. Similar studies were made using un-

fueled spheres of Speer Mod-2 and ATJ graphites for comparison with fueled graphite. Reaction rates ranging from 1 to 5 mg $g^{-1}$ $hr^{-1}$ were found at 900°C for the various fueled spheres, excluding a value of ~0.2 found for the one impregnated lot. Activation energies of ~60 kcal/mole were found from 800 to 1000°C for both the unfueled and the fueled graphite spheres. The reaction rate increased with increasing burnoff over the entire range of burnoff experienced. The $CO/CO_2$ ratio in the effluent gases varied widely. (auth)

**22018** (ORNL-3591(p.205-12)) CHEMICAL SUPPORT FOR SALINE WATER PROGRAM. (Oak Ridge National Lab., Tenn.).

Determinations were made of the solubilities of metastable $CaSO_4 \cdot 2H_2O$ at 40 and 60°C, of metastable $CaSO_4 \cdot \frac{1}{2}H_2O$ at 125°C, and of $CaSO_4$ (anhydrite) at 125, 150, 175, and 200°C in $NaCl-H_2O$ solutions varying from 0 to 4M in NaCl. These data agreed with Debye-Hückel theory at all temperatures and over a wide range of concentration when a function of the ionic strength (I), $I^{\frac{1}{2}}/(1 + 1.5\ I^{\frac{1}{2}})$, was used. Thermodynamic values for the reaction $CaSO_4 \cdot XH_2O$ (solid) $\rightleftharpoons Ca^{2+} + SO_4^{2-} + XH_2O$, in $H_2O$ solution, were calculated. The work on aluminum corrosion in saline water emphasized studies in 1M NaCl at 150°C. In general, aluminum in this environment showed the expected similarity to its behavior in high-purity water. Thus, solution pH and the replacement or relative-area effect were shown to be major variables. Of 11 commercially available alloys tested, the low content magnesium and/or manganese were most promising. (auth)

**22019** (ORNL-3591(p.231-40)) PREPARATION OF PURE MATERIALS. (Oak Ridge National Lab., Tenn.).

The techniques for preparing single crystals of lithium fluoride by a modified Stockbarger method were developed until the total cationic impurity level was reduced to less than 1 ppm, and the procedure was standardized in order to prepare a series of crystals having differing ratios of $^6Li$ to $^7Li$. Results of measurements of the low-temperature thermal conductivity of crystals prepared by this technique (measurements at another laboratory) were reported to permit significant inferences relating isotopic composition to phonon scattering. Zone refining was tested as a means of purifying lithium fluoride from cationic impurities such as manganese, calcium, magnesium, and sodium. Single-pass vertical-tube experiments gave results, which indicated that the separation coefficient for manganese was significantly larger than those for the other ions. A preliminary investigation of the phase diagram of the system $LiF-MnF_2$ did not reveal a basis for an explanation of the behavior of manganese. An automatic, two-zone, apparatus for obtaining more accurate determinations of separation coefficients was constructed. Vacuum volatilization proved to be useful for the purification of LiF, KF, $AlF_3$, and $ZrF_4$. Products with low oxide content were obtained; in the case of KF, because KOH is volatile, a pretreatment of the melt with a fluoride salt which formed an insoluble, nonvolatile, oxide prevented the contamination of the product with KOH. Studies were concluded of the production of pure $Be(OH)_2$ via solvent extraction of beryllium acetylacetonate, $BeX_2$, and ultimate precipitation of the hydroxide from aqueous solution by means of ammonia. Quantitative expressions were developed for the variation of the important extraction system parameters with solution composition at 25°C; the kinetics of the process were studied, and the reaction $BeX^+ + H^+ \rightarrow Be^{2+} + HX$ was shown to be the rate-controlling step in the hydrolysis of $BeX_2$; a quantitative treatment was developed for the decontamination of beryllium from other metallic impurities which form stable species with complexing agents such as EDTA; the efficacy of the process was demonstrated by the purification of beryllium, which was deliberately contaminated with 1000 ppm each of soluble salts of $Na^+$, $Mg^{2+}$, B(III), $Cu^{2+}$, $Al^{3+}$, $Fe^{3+}$, and $Cr^{3+}$. Four batches of product, each equivalent to 500 g of BeO, were produced, in 85% yield, by precipitation upon treatment of a nitrate solution at 75°C with ammonia gas; the total content of all metallic impurities present in measurable amounts was less than 5 ppm. (auth)

**22020** (ORNL-3599) THE EFFECT OF NITRIC ACID, THORIUM, FLUORIDE, AND ALUMINUM ON PROTACTINIUM ADSORPTION BY UNFIRED VYCOR GLASS. J. G. Moore (Oak Ridge National Lab., Tenn.). Apr. 1964. Contract W-7405-eng-26. 19p.

The amount of adsorbable protactinium and its distribution coefficient (DC = counts $min^{-1}$ g of $glass^{-1}$/counts $min^{-1}$ $ml^{-1}$ solution) with 60 to 80 mesh unfired Vycor glass has been determined for $^{233}Pa$ tracer solutions containing 4 to 100 g Th/liter, 0.5 to 12 M $HNO_3$, 0 to 0.04 M HF, and 0 to 0.4 M $Al(NO_3)_3$. The distribution coefficient (DC) from solutions containing only thorium and nitric acid may be calculated as follows: $DC = (378 \pm 72) + (384 \pm 9)x - (1.27 \pm 0.13)xy - (1.13 \pm 1.02)y$, where x = M $HNO_3$, y = g Th/liter. In solutions containing 100 g Th/liter, the coefficient increased slightly with increasing fluoride when the solution was less than about 3.5 M $HNO_3$. At higher nitric acid concentrations, the coefficient decreased with increasing fluoride. The addition of aluminum partially cancelled the effects of fluoride, but the maximum was still only half that of thorium-nitric solution containing no fluoride or aluminum. For example, the coefficient was 3000 for 10 M $HNO_3$, 100 g Th/liter, 300 with 0.04 M HF present, and 1500 with 0.04 M HF, 0.4 M Al present. The amount of unadsorbable protactinium depended only on the nitric acid concentration, ranging from a maximum value of about 7% in 0.5 M $HNO_3$ to less than 2% in solutions containing more than 3 M $HNO_3$. Hot-cell experiments are recommended to test the application of this principle for adsorption of protactinium from short-cooled high-burnup thorium. (auth)

**22021** (UCRL-11103) THE KINETICS OF THE HIGH-TEMPERATURE HYDROLYSIS OF MAGNESIUM FLUORIDE (thesis). Donald R. Messier (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 30, 1964. Contract W-7405-eng-48. 44p.

The rate of hydrolysis of magnesium fluoride was investigated by a gravimetric method as a function of temperature and water-vapor pressure over the ranges from 745 to 835°C and 1 to 20 mm Hg, respectively. A linear rate law was found, and it was concluded that the rate-determining process was a chemical reaction at the $MgF_2$–MgO interface. Preliminary experiments were carried out in a flowing water-vapor atmosphere until a reaction-rate dependence upon flow rate was discovered. Thereafter, a flowing argon–water-vapor atmosphere was used. Single-crystal and polycrystalline specimens were investigated with regard to their suitability for use in rate determinations. Because of orientation effects and a limited supply of single-crystal material, heat-treated slabs of hot-pressed $MgF_2$ were chosen for the final rate determinations. A three-step reaction mechanism is proposed. The first step involves the chemisorption of water vapor:

$$MgF_2(c) + H_2O(g) \underset{k_2}{\overset{k_1}{\rightleftharpoons}} MgF_2 \cdot H_2O(chem).$$

The second step, formation of a hydroxyfluoride complex, can be represented by

$$MgF_2 \cdot H_2O(chem) \xrightleftharpoons[k_4]{k_3} Mg(OH)F(c) + HF(g).$$

The third step, decomposition of the hydroxyfluoride complex to form products, can be written as

$$Mg(OH)F(c) \xrightleftharpoons[k_6]{k_5} MgO(c) + HF(g).$$

With the assumptions that the chemisorption step was in equilibrium and that the HF pressure was negligible, an expression was developed showing that the reaction rate was proportional to the concentration of chemisorbed water vapor. The rate dependence on water-vapor pressure is expressed in terms of the Langmuir-adsorption isotherm equation. Values of −16.9 kcal/mole and −4.2 eu were obtained for the enthalpy and entropy of chemisorption. The activation enthalpy and frequency factor for decomposition of the chemisorbed intermediate, $MgF_2 \cdot H_2O$(chem), were 46.4 kcal/mole and $1.75 \times 10^{10}$ $sec^{-1}$. The low value for the entropy of chemisorption was attributed to possible oversimplification in the interpretation of the reaction mechanism. (auth)

**22022** (UCRL-11229) STUDIES IN MOLECULAR STRUCTURE. I. NEAR-ULTRAVIOLET SPECTRUM OF TETROLALDEHYDE. II. SIMPLE MOLECULAR ORBITAL THEORY OF THE DICHLOROETHYLENES. III. HIGH-TEMPERATURE MICROWAVE SPECTROSCOPY (thesis). James S. Muirhead (California. Univ., Berkeley. Dept. of Chemistry and California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 29, 1964. Contract W-7405-eng-48. 91p.

I. The near-ultraviolet absorption spectrum of tetrolaldehyde vapor was examined. The weak absorption appearing in the 300-400-mμ region was assigned as the $n \rightarrow \pi^*$ transition, and a vibrational analysis places the 0-0 transition at 26,620 $cm^{-1}$ and yields a value for the G=O stretch frequency in the $\pi^*$ state of 1036 $cm^{-1}$. Two other regions of absorption were observed in the 200-300-mμ range, and one of these with center at 47,333 $cm^{-1}$ was tentatively assigned as the $N \rightarrow V$ transition. The second of these appears as weak structure on the long-wavelength edge of the first and may arise from a space-forbidden $\pi \rightarrow \pi^*$ transition. II. A simple molecular orbital treatment, including overlap, was employed to compute the electron distribution and energy eigenvalues of the dichloroethylenes. Comparison with available photoionization potentials, electric dipole moments, and nuclear quadrupole data show, on the whole, a satisfactory agreement between observed and calculated properties. The results obtained are considered to provide support for the occurrence of lone-pair conjugation in the vinyl halides. III. A high-temperature microwave spectrometer was assembled to operate in the temperature range up to 1100°C. The absorptions due to OCS and KCl were observed and the sensitivity of the spectrometer determined. With the present sensitivity of $10^{-7}$ $cm^{-1}$, it should be possible to detect absorptions due to diatomic molecules but not those arising from bent triatomic molecules. The design, construction, and assembly of the spectrometer are described. Several recommendations for design modifications are given. No spectra arising from previously unassigned molecules were found. (auth)

**22023** (NP-tr-1130) THE TECHNICAL MANUFACTURE OF CALCIUM METAL. I. ELECTROLYTIC PROCESSES. Guenther Wehner. Translated by W. Bleyberg (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Freiberger Forschungsh., B17: 18-33(1956). 25p.

The electrolytic process for preparation of metallic calcium, developed by Rathenau, is described. The advantages and disadvantages of this method are outlined. A method developed for the electrolysis of molten calcium chloride on a cathode of liquid copper so as to form a Ca−Cu alloy that is then decomposed by vacuum distillation is described. Studies of Ca−Zn, Ca−Hg, Ca−Si, Ca−C, Ca−Ag, and Ca−Pb for separation of calcium by thermal decomposition and distillation are reported. (M.C.G.)

**22024** INVESTIGATIONS ON ION-EXCHANGE EQUILIBRIA WITH RADIOACTIVE TRACER METHOD. IV. INVESTIGATIONS CONCERNING THE ION-EXCHANGE EQUILIBRIA OF TERNARY MONOVALENT CATIONIC SYSTEMS. Á. Jász and T. Lengyel (Central Research Inst. of Chemistry, Budapest). Acta Chem. Acad. Sci. Hung., 33: 395-8(1962).

Investigations were carried out in order to determine the ion-exchange equilibria at ionic strength $p_c = 3.0$ in the systems Cs−Rb−H, Cs−Na−H, and Rb−Na−H by means of radioactive tracers. The results obtained are represented on triangular diagrams; the coherent values are given as the functions of the initial compositions in the solution. On the basis of the experimental results it is concluded that ternary equilibria set in with the individual validity of the equilibria of the corresponding binary subsystems. Radioactive labeling was carried out with $^{22}Na$, $^{86}Rb$, and $^{134}Cs$ isotopes of high specific activity. (OID)

**22025** ON THE HYDROLYSIS OF NIOBATES IN 3 M K(Cl) MEDIUM. Georg Neumann (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 18: 278-80(1964).

Studies were made on the predominance of hexa- and pentaniobates in solution. A series of emf-titrations were carried out in which the total Nb concentration, B, was kept constant whereas the total $OH^-$ concentration in excess over $Nb(OH)_5$, -H, was varied. The variation of the activity factors was minimized by adding KCl to the solutions and keeping $(K^+) = 3$ M. The data show that the Z [(log $(OH^-)$] curves for the different B values coincided, indicating that all species taking part in the hydrolysis should have the same nuclearity N. (P.C.H.)

**22026** AN ELECTROLYTIC METHOD FOR CONTROLLING THE VALENCE OF IMPURITY IONS IN $CaF_2$ CRYSTAL STRUCTURES. H. Guggenheim and J. V. Kane (Bell Telephone Labs., Murray Hill, N. J.). Appl. Phys. Letters, 4: 172-3(May 15, 1964).

An electrolytic process that changes the valence state of rare-earth ions in $CaF_2$ crystals is discussed. The experimental conversion of trivalent samarium to a divalent state is described. (C.E.S.)

**22027** ABSORPTION SPECTRA OF THE HYDRIDES, DEUTERIDES, AND HALIDES OF GROUP 5 ELEMENTS. C. M. Humphries, A. D. Walsh, and P. A. Warsop (Queen's Coll., Dundee, Scotland). Discussions Faraday Soc., No. 35, 148-57(1963).

Absorption spectra of $PH_3$, $PD_3$, $AsH_3$, $AsD_3$, $SbH_3$, $PF_3$, and $PCl_3$ are discussed in comparison with corresponding data for $NH_3$ and $ND_3$. All electronic transitions observed are Rydberg transitions leading to the first ionization potentials; and all with discrete structure are represented by long progressions in the upper state bending frequency ($\nu_2$) alone. The regularity of all the progressions observed is compatible with the upper states of the molecules being (I) planar; or (II) pyramidal with such a low barrier to inversion that all the transitions observed are to vibrational levels well above the top of the barrier; or (III) pyramidal

with such a high barrier to inversion that all the transitions observed are to vibrational levels well below the top of the barrier. However, consideration of the energies required to change the inter-bond angles in the $PF_3$ and $PCl_3$ molecules from their excited-state values to their ground-state values leads to the conclusion that whereas (I) applies to the Rydberg states of $NH_3$ (and the ground state of the $NH_3^+$ ion), (III) applies to the Rydberg states of $PF_3$ and $PCl_3$ (and the ground states of the $PF_3^+$ and $PCl_3^+$ ions). It is stressed that whereas the spacing of the observed bands for $NH_3$, $ND_3$, $PF_3$, and $PCl_3$ is $\sim\nu_2''$ the spacing of the observed bands for $PH_3$, $PD_3$, $AsH_3$, $AsD_3$, and $SbH_3$ is $\sim\nu_2''/2$. The contrast between $\nu_2'/\nu_2''$ for the latter group of molecules and for $PF_3$, $PCl_3$ on the one hand and $NH_3$, $ND_3$ on the other hand is used as an argument that neither (III) nor (I) applies to the upper states of $PH_3$ ... $SbH_3$ and that these molecules probably have Rydberg states (and positive ion ground states) described by (II). In other words, all the observed spectra can be understood if the removal of a lone-pair electron from a pyramidal molecule causes the bond angle to increase but, provided the molecule does not become planar, makes little change in the vibrational frequency $\nu_2$; the removal of a lone-pair electron from a planar molecule causes the frequency $\nu_2$ to increase; and the Rydberg states of $PF_3$, $PCl_3$ are pyramidal with a high barrier to inversion; the Rydberg states of $PH_3$, $PD_3$, $AsH_3$, $AsD_3$, are pyramidal with a low barrier to inversion; $NH_3$, $ND_3$ are planar to their Rydberg states. (BBB)

**22028** INFRARED SPECTRA OF TITANYL, ZIRCONYL AND THORIUM PERCHLORATES. A. V. R. Warrier, P. Ramamurthy, C. C. Patel, and P. S. Narayanan (Indian Inst. of Science, Bangalore, India). Indian J. Chem., 2: 131-4(1964).

The infrared spectra of crystalline titanyl, zirconyl, and thorium perchlorates were investigated in the form of mull in the region 2-20 $\mu$ to assess the extent of covalent bonding between the perchlorate ion and the metal ion and the influence of the co-ordinated water on the perchlorate ion. A splitting of the triply degenerate mode $\nu_4$ alone of the perchlorate ion was observed and the splitting was found to increase with the size of the metal ion. The crystalline field influence is small and the spectroscopic behavior of the perchlorate ion indicates only a $C_{3v}$ configuration and an unidentate link with the metal ion; the perchlorate ion appears to be bonded to the metal ion through one of its oxygen atoms only. The observed shifts of the frequencies of the water molecules indicate fairly strong hydrogen bonding. (auth)

**22029** A STUDY OF THORIUM SALICYLATES. R. P. Agarwal and R. C. Mehrotra (Univ. of Gorakhpur, India). Indian J. Chem., 2: 142-5(1964).

Complexation reactions of thorium with salicylate ions were investigated by potentiometric, conductometric, and preparative techniques. Formation of mono-, di-, and trisalicylate derivatives was indicated. All the compounds show hydrolytic behavior towards alkalies. (auth)

**22030** EFFECT OF TEMPERATURE AND AGEING ON THE ADSORPTION OF COPPER(II), OXALATE(II) AND DICHROMATE(II) BY DIFFERENT SAMPLES OF HYDROUS BERYLLIUM OXIDE. Rup Dutta (Allahabad Univ., India). Indian J. Chem., 2: 151-3(1964).

The adsorption of copper(II), dichromate(II), and oxalate (II) ions by hydrous beryllium oxide samples prepared by different procedures was studied at different temperatures and after aging the hydrous beryllium oxide samples for different periods. It was observed that adsorption of the various ions increases with increase in temperature, showing that adsorption is an endothermic process and is due to a multilayer adsorption by the hydrous beryllium oxide at higher temperatures. The mode of preparation of the beryllium oxide sample influences its adsorption capacity, which was found to diminish with the age of hydrous beryllium oxide samples. (auth)

**22031** INFRARED SPECTRA OF URANYL SALTS. H. D. Bist and D. D. Pant (D.S.B. Government Coll., Naini Tal, India). Indian J. Pure Appl. Phys., 2: 107-20(1964).

The infrared spectra of a number of uranyl salts were obtained by powder, nujol mull, and potassium bromide pellet techniques with a view to correlating the information thus obtained with that from absorption and emission spectra and other sources. The powder and nujol mull spectra of the uranyl nitrate show that the uranyl frequency ($\nu_3$) shifts from 930 to 945 $cm^{-1}$ depending upon the degree of dehydration, and is accompanied by changes in water and nitrate ion spectra. Only the potassium bromide pellet method in a low uranyl concentration yields the type of spectrum characteristic of uranyl nitrate hexahydrate. With increasing uranyl concentration the nitrate group frequencies manifest themselves and the uranyl $\nu_3$ band broadens and shifts to the higher frequency side. Mixtures of uranyl nitrate hexahydrate and trihydrate show changes in the spectra with increasing uranyl concentration in the potassium bromide pellet technique, and as the dehydration proceeds in the powder technique. These changes are explained on the basis of the coordinating power of the uranyl ion with other radicals or molecules. In this process of coordination the nitrate ion symmetry ($D_{3h}$) is reduced to $C_{2v}$ due to the possible formation of a bidentate complex. This is supported by the observed larger splitting in the $NO_3$ frequencies than in the ON frequencies. In the sulfate, the $\nu_1$ frequency is observed and the $\nu_3$ frequency shows a splitting. The sulfate ion frequencies also show splittings and intensity changes. Two interpretations are possible for these changes: the changes may be associated with the formation of strong complexes due to possible dehydration of the uranyl sulfate; and the split degenerate frequencies of distorted sulfate ion further split up due to factor group splitting. Of these two possibilities the latter appears to be more probable. The spectra of the uranyl halides help in clearly discerning the uranyl frequencies and only the $\nu_3$ frequency and in a few cases the $\nu_1$ frequency are observed. There is some evidence for the occurrence of the combination frequency ($\nu_1 + \nu_3$) and no combinations with the $\nu_2$ frequency are observed. The water frequencies in uranyl fluoride and chloride show two types of bindings. One set of frequencies are very sharp and shifted less with respect to the vapour bands in both the stretching and bending regions, than the other. The occurrence of the $\nu_1$ frequency of the uranyl ion was observed in the sulfate, fluoride, and chloride. In all these cases, the $\nu_3$ frequency shows splittings and the fluorescence spectra have a violet companion band. (auth)

**22032** THE CRYSTAL STRUCTURE OF THORIUM TETRAIODIDE. Allan Zalkin, J. D. Forrester, and David H. Templeton (Univ. of California, Berkeley). Inorg. Chem., 3: 639-44(May 1964). (UCRL-10962)

Thorium tetraiodide has a novel layer structure in the solid according to single-crystal x-ray diffraction data. The crystals are monoclinic, space group $P2_1/n$, with $a = 13.216 \pm 0.007$, $b = 8.068 \pm 0.006$, $c = 7.766 \pm 0.006$ Å, $\beta = 98.68 \pm 0.05°$, $Z = 4$, $d_x = 6.00$ g/cc. Each thorium atom has eight iodine neighbors at an average distance of 3.20 Å at the corners of an irregular polyhedron, which is

approximately a square antiprism. The polyhedra share edges and triangular faces to form layers, which are only weakly bonded to each other. (auth)

**22033** PROPERTIES OF URANIUM(V) IN HYDROFLUORIC ACID SOLUTION; THE NEW COMPOUNDS $HUF_6 \cdot 2.5H_2O$ AND $HUF_6 \cdot 1.25H_2O$. L. B. Asprey and R. A. Penneman (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem., 3: 727-9(May 1964). (LADC-6122)

Anhydrous $UF_5$ is very soluble in concentrated aqueous HF; the resulting solutions of U(V) in ca 10–27 M HF are remarkably stable. Blue crystals of $HUF_6 \cdot 2.5H_2O$ are formed when a 5 M solution of U(V) is cooled from 25 to –10°C. The spectrum of $HUF_6 \cdot 2.5H_2O$ crystals shows prominent absorption at 1.36 $\mu$, strikingly similar to that shown by anhydrous $LiUF_6$, $NaUF_6$, and $CsUF_6$. $UF_5$ is essentially insoluble in anhydrous liquid HF but $HUF_6 \cdot 2.5H_2O$ dissolves. A lower hydrate, $HUF_6 \cdot 1.25H_2O$, is obtained from a solution of U(V) in 85-90% HF. The anhydrous acid, $HUF_6$, could not be prepared. Cesium and rubidium form macrocrystalline salts, $CsUF_6$ and $RbUF_6$, which are precipitated readily by addition of CsF or RbF to a solution of U(V) in aqueous HF. A nonuranyl structure, $UF_6^-$, is postulated as the form of U(V) in the hydrates of $HUF_6$ and in concentrated aqueous hydrofluoric acid solutions. (auth)

**22034** HYDROLYSIS OF URANIUM CARBIDES BETWEEN 25 AND 100°. III. URANIUM SESQUICARBIDE AND MIXTURES OF THE SESQUICARBIDE WITH MONOCARBIDE OR DICARBIDE. Mildred J. Bradley and Lesley M. Ferris (Oak Ridge National Lab., Tenn.). Inorg. Chem., 3: 730-4(May 1964). (ORNL-TM-705)

Reactions with water of heat-treated (60 hr at 1600°) uranium carbides with total-C : U atom ratios varying from 1.0 to 2.0 were investigated using gas chromatography for analysis of the gaseous products. Uranium sesquicarbide $[U_4(C_2)_3]$ yielded a gas containing hydrogen (59 vol %) and hydrocarbons (methane, 2 vol %; ethane, 26%; $C_3$ to $C_8$ alkanes, 6%; alkenes, 7%; alkynes, 0.6%; and unidentified unsaturates, 0.8%), a water-insoluble wax, and a hydrous uranium(IV) oxide. Fifty per cent of the carbon was found in the gas and 10% in the wax. Varying the reaction temperature between 25 and 99°C caused no change in the hydrolysis products. Uranium monocarbide–sesquicarbide mixtures (UC to $UC_{1.5}$) produced less methane and more $C_2$ to $C_8$ hydrocarbons than expected, indicating that polymerization involving single carbon units from the monocarbide had occurred. Hydrolysis of sesquicarbide–dicarbide mixtures ($UC_{1.5}$ to $UC_{1.85}$) yielded the products expected from the behavior of the separate compounds—principally $C_2$ to $C_8$ hydrocarbons with some hydrogen and a little methane. No uranium sesquicarbide was formed when an as-cast specimen with a combined-C : U atom ratio of 1.86 was heat treated under conditions where uranium sesquicarbide should have formed if the as-cast specimen were a mixture of UC and $UC_{2.0}$. This further confirms prior work showing that $UC_{1.85 \pm 0.03}$ is the composition of the dicarbide. (auth)

**22035** HYDROLYSIS OF MOLYBDENUM(VI). ULTRACENTRIFUGATION, ACIDITY MEASUREMENTS, AND RAMAN SPECTRA OF POLYMOLYBDATES. J. Aveston, E. W. Anacker, and James S. Johnson (Oak Ridge National Lab., Tenn.). Inorg. Chem., 3: 735-46(May 1964).

The aggregates formed on acidification of alkali molybdate solutions were studied by equilibrium ultracentrifugation, by potentiometric acidity measurements, and by Raman spectroscopy. Equilibrium ultracentrifugation indicates that polymerization increases sharply between p = 0 and p = 1, and that species having average degrees of polymerization of 6-9 occur in the range p = 1–1.5, where p is the average number of protons bound per molybdenum. Higher molecular weights are found for p > 1.5; with excess acid, molecular weights decrease, but some polymerization appears to persist even in 3M excess HCl. Acidity measurements up to p = 1.5 can be explained equally well by schemes involving monomer–heptamer, monomer–octamer, or monomer–heptamer–octamer equilibria. Comparison of the Raman spectra of solutions and of solids, whose aggregation is known from x-ray evidence, indicates that the paramolybdate ($Mo_7O_{24}^{6-}$) ion exists in solution at p ca 1.14, and that octamolybdates ($Mo_8O_{26}^{4-}$) occur in solutions of p about 1.5. There is no evidence for the presence of important amounts of species having degrees of polymerization intermediate between monomers and heptamers under the conditions studied. Although there is some indication of counterion ($Na^+$ or $Li^+$) binding by the polymolybdates, the evidence is inconclusive. Volumes and refractive index increments of hydrolyzed molybdate solutes are reported. (auth)

**22036** TERNARY PEROVSKITE PHASES IN SYSTEMS OF LITHIUM HYDRIDE WITH BARIUM, STRONTIUM, AND CALCIUM HYDRIDES. Charles E. Messer, Judith C. Eastman, Robert G. Mers, and Arnulf J. Maeland (Tufts Univ., Medford, Mass.). Inorg. Chem., 3: 776-8(May 1964).

Studies were made on phase equilibria in lithium hydride systems with barium, calcium, and strontium hydrides. In each of the powder patterns except that of the $LiH-CaH_2$ mixture, a series of 21-27 sharp, well-defined lines was found, which could be indexed on the basis of a primitive cubic unit cell of Ba or Sr. By analogy with $LiBaF_3$, these were interpreted in terms of inverse perovskite lattices of $LiBaH_3$ and $LiSrH_3$. The crystallographic constants of the perovskite phases were: $LiBaH_3$ $a_0 = 4.023 \pm 0.001$ Å, $\rho = 3.756$ g cm$^{-3}$; $LiSrH_3$ $a_0 = 3.833 \pm 0.001$, $\rho = 2.877$ g cm$^{-3}$. The uniformity of the lattice constant values of $LiBaH_3$ and $LiSrH_3$ suggests that departures from stoichiometry in these phases cannot be very large, at least not at room temperature. (P.C.H.)

**22037** CATHODE POLARIZATION OF LITHIUM ON A GALLIUM CATHODE. V. P. Porubaev, V. D. Ponomarev, and A. I. Zazubin. Izv. Akad. Nauk Kaz. SSR, Ser. Tekhn. i Khim. Nauk, No. 2, 60-7(1963).

The influence of certain factors on the potential of a gallium cathode in various electrolytes was studied. Lithium carbonate and lithium chloride solutions were used. Data on the study of dependency of gallium cathode potential on current density and concentration of the given electrolytes at 30°C are presented. Current densities from 25 to 2000 a/m$^2$ were used and the effect of acidity of the electrolyte solution on lithium concentration at the cathode, hence on penetration of the gallium and polarization was noted. (TCO)

**22038** ADSORPTION AND MIGRATION OF Sr ON W. B. E. Barnaby, T. E. Madey, A. A. Petrauskas, and E. A. Coomes (Univ. of Notre Dame, Ind.). J. Appl. Phys., 35: 1759-63(June 1964).

A study of the migration of Sr on W by a field electron emission technique revealed two modes. In the first mode for $\theta \geq 1$, migration proceeds with a sharp boundary while in the second mode, $\theta < 1$, no boundary is observed. The activation energy for the first mode was found to be 0.79 ± 0.06 ev/atom, and the activation energy for the second mode was found to be 1.44 ± 0.08 ev/atom. (auth)

**22039** X-RAY LINE BROADENING IN CALCIUM FLUORIDE. D. Lewis and H. Pearson (Battersea Coll. of Tech., London). J. Appl. Phys., 35: 1939-41(June 1964).

X-ray diffraction profiles of calcium fluoride show broadening that is partly caused by small crystallites and partly by deformation. Annealing eliminates most of the broadening and is accompanied by a parameter change that takes place between room temperature and 250°C and is probably associated with the precipitation of calcium oxide. By cold working the annealed calcium fluoride, it was possible to produce a specimen showing profile integral breadths equal to the original material, but which analysis showed to be caused almost entirely by strain. (auth)

**22040** SINGLE-CRYSTAL GROWTH OF $LaF_3$. P. F. Weller and J. A. Kucza (International Business Machines Corp., Yorktown Heights, N. Y.). J. Appl. Phys., 35: 1945-6(June 1964).

Single crystals of $LaF_3$ were grown by the Čzochalski technique. Crystal clarity and perfection were strongly dependent on the amount of oxide impurity. Trivalent rare-earth doping was easily achieved, and divalent doping was possible with the easily reduced rare earths such as europium and samarium. (auth)

**22041** ENERGY BAND STRUCTURE OF POLYNUCLEOTIDES IN THE HUECKEL APPROXIMATION. J. Ladik and K. Appel (Central Research Inst. for Chemistry, Budapest). J. Chem. Phys., 40: 2470-3(May 1, 1964).

Taking as model systems the polynucleotides poly A, poly T, poly G, poly C, and poly U in a stereo arrangement according to the Watson-Crick model of DNA, the energy bands of these macromolecules were calculated in the Hückel approximation. Simple polynomial expressions were found for the energy values as functions of cosk, and with the aid of these the limits of all the occurring energy bands were determined. Some features of the obtained band structures are discussed. (auth)

**22042** ELECTRON SPIN RESONANCE OF AMINE SOLUTIONS OF ALKALI METALS. Kedma Bar-Eli and T. R. Tuttle, Jr. (Brandeis Univ., Waltham, Mass.). J. Chem. Phys., 40: 2508-19(May 1, 1964).

Nuclear hyperfine structure was observed in the electron spin resonance (ESR) absorption spectra of potassium and lithium dissolved in some alkylated amines. The four-line spectrum displayed by the potassium solutions is attributed to $^{39}K$-electron contact interaction. This interaction increases with increasing temperature. The spin density at the potassium nucleus in ethylamine solution is $3.37 \pm 0.05 \times 10^{23}$ cm$^{-3}$ at −40°C and $1.21 \pm 0.05 \times 10^{24}$ cm$^{-3}$ at 50°C. The contact interaction also decreases when methylamine is added to an ethylamine solution. This behavior is interpreted in terms of a modified view of the monomer. The monomer changes its structure as its environment changes. A statistical model that relates the experimental observations to these changes was constructed. The differences in the ESR absorption spectra observed for the three systems $Na-NH_3$, $K-EtNH_2$, and $Li-EtNH_2$ are discussed, and in part, attributed to differences among the three systems in the rates of spin exchange, electron exchange, and solvent exchange. Order-of-magnitude calculations relating measured line breadths to the rates of these processes were carried out in certain limiting cases. The results of the calculations lend support to the idea that the monomer includes remote solvent molecules within its structure. The rate constant for spin exchange is shown to increase with decreasing temperature in some potassium–amine solutions. No evidence for the solvated electron was found in the ESR spectra of K dissolved in ethylamine, or in a range of mixtures of ethylamine with methylamine. An upper limit of $10^{-4}$ was placed on the dissociation constant of the monomer. For Li in ethylamine a composite spectrum was observed under some conditions. It consists of a nine-line hyperfine pattern superimposed on a single relatively sharp line with the same g value. The sharp line is attributed to the solvated electron. The nine-line pattern is attributed to hyperfine interaction between the unpaired electron and four equivalent $^{14}N$ nuclei in the Li monomer. The spin density at each $^{14}N$ is $1.4 \pm 0.1 \times 10^{23}$ cm$^{-3}$, independent of temperature. Similar spectra were observed for Li dissolved in two mixed amine solvents. The size of the monomer is discussed in terms of an expanded orbital approach. The K monomer is shown to vary between two and three times the size of atomic K. The trend toward lower percent atomic character with decreasing atomic number of the alkali metal is also discussed. Part of this trend may come about because the small atoms undergo a larger expansion in forming a monomer. (auth)

**22043** ADSORPTION-DESORPTION OF HYDROGEN ON TUNGSTEN AND MOLYBDENUM. George E. Moore and F. C. Unterwald (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 40: 2626-38(May 1, 1964).

Adsorption of hydrogen on tungsten and molybdenum was investigated over the range 300 to 1000°K using a mass spectrometer. These phenomena alone were observed below about 1200°K. A mass spectrometer affords a practical method for studying different adsorbates simultaneously adsorbed. Although the method is less sensitive than those depending on measurements of total pressure, it does not require the dangerous assumptions made tacitly in much published work employing the latter method. Molecular hydrogen is readily desorbed below 900°K from both W and Mo, although somewhat less so from Mo. The amount remaining is probably not over $10^{-5}$ monolayer. Over the experimental range, only one mode of adsorption–desorption was detected. Despite intense effort, CO, $H_2O$, and $CH_4$ were never eliminated. CO is much more tenaciously bound than hydrogen and thus may have confused earlier measurements for hydrogen. $H_2O$ and $CH_4$ do not compete successfully with hydrogen for adsorption sites; they were less tenaciously adsorbed and their abundance was low. (auth)

**22044** THERMAL DISSOCIATION OF HYDROGEN. George E. Moore and F. C. Unterwald (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 40: 2639-52(May 1, 1964).

Thermal dissociation or atomization, $H_2 \rightleftharpoons 2H$, on a Mo or W catalyst, from 1200° to 2500°K, is described. Transient behavior of individual species (especially H) caused by changing catalyst temperature is emphasized. Reaction rates, and equilibria derived from them, confirm Langmuir's results of 50 years ago and disagree with more recently published reaction rates 200-fold faster. Transient behavior above 1200°K was dominated by diffusion; this suggests that neither surface atomization mechanism usually favored is important. The transient methods permit evaluation of parameters fundamental for diffusion and for solution of hydrogen in W or Mo, from $10^{-7}$ to $10^{-4}$ Torr, well below the range of the Fowler-Smithells theory. These may be the first quantitative diffusion data published for the tungsten–hydrogen system. Data are tabulated. (P.C.H.)

**22045** LOW-FREQUENCY MOTIONS OF $H_2O$ MOLECULES IN CRYSTALS. Henri Boutin (Picatinny Arsenal,

Dover, N. J. and Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 40: 2670-9(May 1, 1964). (BNL-7615)

A number of selected samples containing water of crystallization or adsorbed water were systematically examined by neutron inelastic scattering using the Brookhaven slow chopper to study translational and librational motions of the $H_2O$ molecules in a region lying below 800 $cm^{-1}$. To gain an understanding of these motions in various configurations, spectra were measured for polycrystalline samples of natrolite (isolated $H_2O$ molecules in a cavity); chabazite (waterlike $H_2O$ molecules); analcime (two $H_2O$ molecules per cavity); apophyllite (distorted $H_2O$ molecules); copper sulfate pentahydrate ($H_2O$ molecules forming hydrogen bonds of various lengths with the lattice); and beryl (adsorbed monomeric $H_2O$ molecules). Despite the large variety of lattice configurations and bonding forces, all these compounds, with the exception of beryl, show peaks corresponding to torsional motions of the $H_2O$ molecules in a narrow frequency region (480 to 600 $cm^{-1}$). Beryl, however, shows only a broad spectrum centered approximately at kT, as expected for weakly bound $H_2O$ molecules. Besides indicating the frequencies of torsional motions and the degree of rotational freedom of the $H_2O$ molecules, the measurements provide information concerning: distribution of water molecules among various lattice sites, influence of the distortion of the $H_2O$ molecules on the observed frequencies, and the effects of its environment on the translational modes of the $H_2O$ molecules. (auth)

**22046** DETERMINATION OF THE LENNARD-JONES PARAMETERS FROM TOTAL SCATTERING CROSS-SECTION MEASUREMENTS. S. A. Lebedeff (Univ. of California, Berkeley). J. Chem. Phys., 40: 2716-21(May 1, 1964).

Two methods are described that permit the determination of potentials from molecular scattering experiments. The potentials under consideration are of the Lennard-Jones type. Both methods apply to high-energy scattering, where the Born approximation is suitable for determination of the high angular momentum phase shifts. The methods are first checked against the exact calculations of Bernstein and then applied to the determination of the potential parameters of the krypton-lithium system. Finally, a partial analysis of the argon–lithium system is done. It provides an efficiency test for the high-energy approximation method. (auth)

**22047** CALCULATIONS OF THE SURFACE ENERGY FOR SOME ORTHORHOMBIC SULFATES. A. G. Walton and D. R. Whitman (Case Inst. of Tech., Cleveland). J. Chem. Phys., 40: 2722-4(May 1, 1964).

The surface energy for the 100 faces of barium, strontium, lead, and calcium sulfates was calculated for various sizes of very small crystals. The values, when extrapolated to infinite surface area, give for the average surface energy 994, 1110, 1062, and 574 ergs/$cm^2$, respectively. (auth)

**22048** MASS SPECTROMETRIC STUDY OF THE ISOTOPIC EXCHANGE RATE OF OXYGEN ATOMS WITH $O_2$, NO, AND $NO_2$. John T. Herron and Fritz S. Klein (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 40: 2731-3(May 1, 1964).

The isotopic exchange rate of oxygen atoms with $O_2$, NO, and $NO_2$ was studied and the rate constants were measured. In the exchange with molecular oxygen the calculation had to include the simultaneous exchange of $^{16}O^{16}O$, $^{16}O^{18}O$ (formed during the reaction), and $^{18}O^{18}O$ with $^{18}O$ and $^{16}O$ atoms. The best results were obtained by observing the rate of change in $^{16}O^{16}O$ concentration, since atom-atom recombination affects this species least. In the NO exchange the contribution from $^{18}O^{18}O$ exchange had to be included in the calculation of the equilibrium isotope concentration of $N^{16}O$. The $NO_2$ isotope exchange turned out to be comparable in rate to the reaction $NO_2 + O \rightarrow NO + O_2$, so that allowance had to be made for the decrease in total $NO_2$ concentration during the exchange and for the loss in exchanged $N^{16}O^{18}O$ due to the above reaction. The exchange rates obtained were: $k_{O_2} = 0.6 \times 10^{12}$; $k_{NO} = 1.1 \times 10^{12}$; and $k_{NO_2} = 4.2 \times 10^{12}$ cc $mole^{-1}$ $sec^{-1}$, all at 37°C. (P.C.H.)

**22049** MASS SPECTROMETRIC STUDY OF VAPOR EJECTED FROM GRAPHITE AND OTHER SOLIDS BY FOCUSED LASER BEAMS. J. Berkowitz and W. A. Chupka (Argonne National Lab., Ill.). J. Chem. Phys., 40: 2735-6 (May 1, 1964).

A magnetic mass spectrometer was used to analyze the composition of the vapor ejected from graphite by focused laser beams. Relative ion intensities of the various carbon peaks did not vary significantly for different graphite samples. The $C_3 : C$ ratio in the experiments was very close to the value extrapolated from equilibrium experiments. It was concluded that, in the region of the last molecular collision before sampling, the vapor is saturated or perhaps supersaturated. With a boron target, peaks of $B^+$ (n = 1,2...,5) were observed. Using a Mg target, $Mg^+$ and an $Mg_2^+$ peak, which increases rapidly with laser power, is observed. (P.C.H.)

**22050** EFFECT OF A SUBSTITUENT OF THE $^{57}Fe$ MÖSSBAUER SPECTRUM OF CERTAIN FERROCENE DERIVATIVES. A. V. Lesikar (California Inst. of Tech., Pasadena). J. Chem. Phys., 40: 2746-7(May 1, 1962).

The results of measurements of the $^{57}Fe$ Mössbauer spectrum using a group of 11 ferrocene derivatives as absorbers are reported. The main features of the results are the small decrease in the quadrupole coupling in the substituted ferrocenes from the value of the coupling in the unsubstituted ferrocene, and the constancy of the isomeric shift through the series of derivatives. Data are tabulated. (P.C.H.)

**22051** MEAN AMPLITUDES OF VIBRATION FOR BORON, SILICON, TITANIUM, AND ZIRCONIUM DIOXIDES. G. Nagarajan (Annamalar Univ., Annamalainagor, South India). J. Chim. Phys., 61: 335-7(Mar. 1964). (In French)

Some analyses of the vibration spectra of $BO_2$, $SiO_2$, $TiO_2$, and $ZrO_2$ are summarized. Fundamental frequencies from these analyses were used to calculate the force constants of the four dioxides by the method of Wilson groups. The force constants are tabulated, together with mean amplitudes and mean quadratic amplitudes of vibration calculated for temperatures of 0 and 298°K. (D.C.W.)

**22052** REACTIONS OF SOME ATOMS OR FREE RADICALS ON $H_2S$ AND $D_2S$. Guy Pannetier, Pierre Goudmand, Odile Dessaux, and Nicole Tavernier (Faculte des Sciences, Paris). J. Chim. Phys., 61: 395-406(Mar. 1964). (In French)

Flame spectra obtained by injection of a slight flow of $H_2S$ or $D_2S$ into a jet of hydrogen, oxygen, nitrogen, or OH were studied. Emission in the pyrolysis of $H_2S$ in a shock tube was spectroscopically examined. The results of the observations were compared with those obtained by substituting $H_2O$ for $H_2S$. (D.C.W.)

**22053** THE REACTIONS OF NIOBIUM(V) AND TANTALUM(V) CHLORIDES AND BROMIDES WITH SOME NITROGEN LIGANDS. M. Allbutt, K. Feenan, and G. W. A. Fowles (Univ. of Southampton, Eng.). J. Less-Common Metals, 6: 299-306(Apr. 1964).

The reactions of $MX_5$ (M = Nb, Ta; X = Cl, Br) with pyridine and γ-picoline (L) were found to give complexes ($MX_4$,2L) of the quadrivalent elements. The bidentate ligands (B) bipyridyl and 1:10 phenanthroline were found to react with $NbCl_5$ and $TaCl_5$ to give the compounds $MCl_4$,B. The spectra and magnetic properties of the compounds were measured and their significance discussed. (auth)

**22054** REPORT ON THE CHEMISTRY OF NIOBIUM AND TANTALUM. XXXII. THE FORMATION ENTHALPY OF THE COMPOUNDS NIOBIUM AND TANTALUM CHLORIDE. Harald Schaefer and Franz Liedmeier (Universität, Münster, Ger.). J. Less-Common Metals, 6: 307-12(Apr. 1964). (In German)

The enthalpy of formation of the compounds $NbCl_2$, $Nb_3Cl_8$, $NbCl_{3.13}$, $TaCl_{2.5}$, and $TaCl_3$ was determined by reaction with chlorine in a bomb calorimeter. (auth)

**22055** INFRARED SPECTRA OF ISOTOPIC NITROUS OXIDES. Josef Plíva (Inst. of Physical Chemistry, Prague). J. Mol. Spectry., 12: 360-86(Apr. 1964).

The infrared spectra of $^{15}N^{14}N^{16}O$ and $^{15}N_2{}^{16}O$ were measured with a high-resolution grating spectrometer in the region between 2100 and 4450 $cm^{-1}$. The spectrum of the ordinary species, $^{14}N_2{}^{16}O$, was remeasured for comparison in order to obtain accurate values of the isotopic displacements. Twelve vibration-rotation bands of each isotopic species were analyzed. From the rotational constants obtained it was possible to determine improved equilibrium internuclear distances ($r_{N-N}$ 1.1282 Å, $r_{N-O}$ 1.1842 Å) for the nitrous oxide molecule. (auth)

**22056** STUDY OF RELAXATION PROCESSES IN Nd USING PULSED EXCITATION. G. E. Peterson and P. M. Bridenbaugh (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Opt. Soc. Am., 54: 644-50(May 1964).

Relaxation processes in Nd were studied. It was found that resonance coupling between Nd and other rare earth ions seems to exist. Nd plus Yb in $Na_{0.5}Gd_{0.5}WO_4$ results in a coupled system in which the Yb may be caused to fluoresce by pumping the Nd. Radiation trapping was found to play only a minor role. (auth)

**22057** $4f^3$ AND $4f^25d$ CONFIGURATIONS OF DOUBLY IONIZED PRASEODYMIUM (Pr III). Richard E. Trees (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Am., 54: 651-7(May 1964).

The positions of 38 observed levels of the $4f^3$ configuration of Pr III were calculated with a rms error of ±168 $cm^{-1}$, by use of seven adjustable parameters. The interaction with the $4f5d^2$ levels is discussed. A calculation of the levels of the $4f^25d$ configuration was obtained with a rms error of ±182 $cm^{-1}$ relative to the 101 observed levels, utilizing 13 adjustable parameters. (auth)

**22058** EXAMINATION OF MASS TRANSPORT IN THE VAPOR PHASE BY MEANS OF $^{24}$NaCl. Gyoergy Turchanyi, Tuende Horvath, and Imre Tarjan (Inst. for Medical Physics, Budapest). Magy. Fiz. Folyoirat, 11: 453-63 (1963). (In Hungarian)

Following previously published studies on the heat treatment of tempered NaCl discs, (Magy. Fiz. Folyoirat, 10: 81(1962)), the distribution of $^{24}$NaCl introduced in a superimposed, separated system of NaCl discs was investigated. The half life of γ radiation of $^{24}$NaCl is about 15 hours; the thickness of its Pb half-value layer is 16 mm. Using a solution with an activity of 2 mC/ml, a given amount was transferred to the surface of the disc and the liquid allowed to evaporate. After heat-treatment, the examined portion of the disc was dissolved and its activity was measured by means of a NaCl(Tl) crystal connected to a decimal scaler. The factors controlling the decrease of the activity of the treated discs and the transfer of the activity to the neighboring discs were systematically examined. It is concluded that the interaction of the heat-treated specimens involves not only a simple diffusion phenomenon or the action of migrating vapor molecules but also the effect of over-heated drops. From observation of the process it appears probable that particles of various size move back and forth in the space between the discs, become attached to the discs and are subsequently removed from the surface. (TTT)

**22059** SIMPLE ONE-CENTRE CALCULATION OF BREATHING FORCE CONSTANTS AND EQUILIBRIUM INTERNUCLEAR DISTANCES FOR FIRST ROW DIATOMIC HYDRIDES. D. M. Bishop and J. R. Hoyland (Carnegie Inst. of Tech., Pittsburgh). Mol. Phys., 7: 161-4(1963-64).

Total molecular energies, force constants and equilibrium internuclear distances are determined for the LiH, BeH, BH, CH, NH, and OH molecules using a single-determinant wave function of one-center form and composed of Slater orbitals, s, s*, $p_x$, $p_y$, and $p_z$ with the orbital center taken as a variational parameter. The values so obtained are compared with experimental values. (auth)

**22060** REACTIONS OF CHLORINE WITH URANIUM OXIDES. J. Zienkiewicz (Inst. for Nuclear Research, Warsaw). Nukleonika, 8: 803-25(1963). (In Russian)

Studies on the system ($UO_x$, $Cl_2$) show that $UO_2$ reacts at the temperature of 225°C, while $U_3O_8$ and $UO_3$ do not react till the temperature of 900°C. Introduction of carbon in the system reduces the reaction to below 300°C. Composition of the products depends on the temperature of the reaction zone; raising the temperature decreases the content of oxygen from 2 to 0, the content of chlorine increases from 2, having a maximum of 5, and decreases to 4. Introduction of CO instead of carbon leads to reduction of the efficacity. (auth)

**22061** THE CUBIC FIELD SPLITTING OF THE GROUND STATE OF $Eu^{2+}$ IN ALKALINE EARTH OXIDES. J. Overmeyer and R. J. Gambino (IBM Corp., Yorktown Heights, N. Y.). Phys. Letters, 9: 108-9(Apr. 1, 1964).

It is shown that a sign reversal occurs in the fourth order splitting coefficient for europium in barium oxide crystals as the lattice constant is increased. Spin hamiltonian constants for $^{2+}$Eu in calcium, strontium, and barium oxides are compared and the Eu:BaO spectrum is presented. (L.B.S.)

**22062** ABSENCE OF PRONOUNCED QUADRUPOLE EFFECTS IN THE NUCLEAR RESONANCE OF $In^{115}$ IN A NONCUBIC ENVIRONMENT. Lawrence H. Bennett and Rex J. Snodgrass (National Bureau of Standards, Washington, D. C. and Univ. of Maryland, College Park). Phys. Rev., 134: A1290-3(June 1, 1964).

The nuclear magnetic resonance of $^{115}$In was observed throughout the cubic phase of Pb–In alloys, at 77 and 300°K. The Knight shift is 0.86% and is essentially unchanged with composition. The linewidths increase rapidly with In concentration, probably mostly due to pseudodipolar interaction. The average electric field gradient at a $^{115}$In nucleus for any configuration of Pb neighbors is about $q \sim 3 \times 10^{22}$ $cm^{-3}$, about 20 times smaller than for Cu having a Zn second neighbor in the f-c-c Cu lattice. The small value of the field gradient is discussed in terms of the behavior of the charge oscillations and is related to the small change in Knight shift for $^{207}$Pb in these same alloys. (auth)

**22063** NUCLEAR MAGNETIC RESONANCE IN LEAD ALLOYS. Rex J. Snodgrass and Lawrence H. Bennett (National Bureau of Standards, Washington, D. C. and Univ. of Maryland, College Park). Phys. Rev., 134: A1294-5 (June 1, 1964).

The $^{207}Pb$ nuclear magnetic resonance was measured in a series of lead base primary solid solutions containing Cd, In, Sn, Sb, Hg, Tl, and Bi as solutes. The central resonance frequency of $^{207}Pb$ shifts in proportion to the solute concentration and in the opposite direction to be explained by impurity charge screening of the Thomas-Fermi type. The fractional change in Knight shift for all solutes is small $\Delta k/k \approx 0.05$ c. The important parameter in determining the change in Knight shift seems to be the difference in valence between the impurity atoms and the lead atoms. The absorption linewidths broaden rapidly upon the addition of solute. In the absence of a quantitative calculation it is not possible to determine if the small shifts, large widths, and small quadrupole effects of $^{115}In$ are consistent with the theory of long-range oscillations of electric charge. However, there is evidence that this theory may be capable of explaining the data. (auth)

**22064** ON THE MEASUREMENT OF THE ISOTOPE RATIO OF POTASSIUM. Takuji Komori and Shuzo Tamura (Japan Atomic Energy Research Inst., Tokyo). Shitsuryo Bunseki, 11: No. 23, 112-16(Oct. 1963). (In Japanese)

A mass-spectrometric study was carried out on measurement of the isotopic ratio of potassium using a surface ionization ion source. The pretreatment of the sample filaments for removing background potassium was studied using enriched $^{41}K$ isotope (96%) on rhenium, tantalum, and tungsten filaments. Chloride, nitrate, and sulfate of potassium were examined as sample materials for the measurement of isotopic ratios. Time variations of $^{39}K/^{41}K$ ratio during one run were observed with potassium chloride and potassium iodide samples, and the isotope fractionation effect in the ion source was studied. Among these compounds, potassium iodide was preferable as a sample material because of the large ionizing efficiency and the small isotope fractionation. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**22065** CATHODIC PROCESSES IN THE ELECTROLYSIS OF NaCl–KCl MELTS CONTAINING $UCl_3$, $UCl_4$, AND $UO_2Cl_2$. M. V. Smirnov and O. V. Skiba. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Uralsk Filial., No. 4, 17-28 (1963).

A study was made of the cathodic polarization of Mo electrodes in NaCl–KCl–$UCl_3$ melts containing 0.5, 1.0, 3.5, and 12 wt % U, at 690, 700, and 900° and $D_c = 10^{-4} - 10$ a/cm$^2$. It was confirmed that metallic U deposits on the cathode as a result of the primary discharge of $U^{3+}$ ions. The cathodic polarization of Mo and Pt electrodes was studied in NaCl–KCl–$UCl_4$ melts containing 3.0 and 7.6 wt % U, at 700, 800, and 850°C at $D_c = 10^{-4} - 10$ a/cm$^2$. It was found that the deposition of metallic U on the cathode is preceded by residual currents due to the conversion of $U^{4+}$ ions to $U^{3+}$ ions, and to the discharge of $UO_2^+$. Polarization of Pt cathodes was studied in NaCl–KCl–$UO_2Cl_2$ melts containing 1.7 and 7.6 wt % U at 700 and 800°C at $D_c = 10^{-4} - 10$ a/cm$^2$. It was found that $UO_2$ deposits on the cathode, as does the metal, via direct discharge of the complex cation $UO_2^{2+}$ at higher positive potentials than the cations associated with the conversion of $U^{4+}$ to $U^{3+}$ and their discharge to the metal. (Referativnyy Zhurnal, Metallurgiya, No. 1, Jan. 1964)

**22066** HEATS AND ENTROPIES OF IONS IN AQUEOUS SOLUTION. E. Glueckauf (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Faraday Soc., 60: 572-7(Mar. 1964).

An equation for the heats and entropies of hydration of single ions in water was deduced on the basis of a variable dielectric constant near the ion, and of the existence of vacant space close to the surface of the ion. Agreement with the observed trends is good. (auth)

**22067** INVESTIGATION OF STIMULATED EMISSION OF $Nd^{3+}$ IN $CaF_2$ AT ROOM TEMPERATURE. A. A. Kaminskii, L. C. Kornienko, L. V. Makarenko, A. M. Prokhorov, and M. M. Fursikov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 46: 386-9(Jan. 1964). (In Russian)

In previous experiments, stimulated emission from $^{3+}Nd$ was observed only for $SrF_2$ at room temperature. In the present work $^{3+}Nd$ in $CaF_2$ was investigated at room temperature for concentrations of $Nd_2O_3$ from 0.3 to 1.5%. The stimulated emission was observed at a wavelength of 1.047$\mu$. The infrared luminescence of $^{3+}Nd$ in $CaF_2$ corresponded to transitions from $^4F_{3/2}$ levels to $^4I$ multiplets, of which $^4I_{11/2}$ was the strongest. It is shown that absorption lines increase linearly in intensity as the percentage of $^{3+}Nd$ increases from 0.2 to 1.5% with no apparent broadening of the lines. Paramagnetic resonance studies showed that part of the $^{3+}Nd$ ions are in electrical fields of tetragonal symmetry, part in fields of orthorhombic symmetry, the latter increasing as the square of the $^{3+}Nd$ concentration. The time dependence of the emitted radiation was studied. A series of bursts were observed lasting about 5 $\mu$sec each, for a total duration of 250 $\mu$sec. Threshold energies were measured. (TTT)

**22068** THERMODYNAMICS OF TANTALUM CHLORIDES. A. R. Kurbanov, A. V. Suvorov, S. A. Shchukarev, and G. I. Novikov. Zh. Neorgan. Khim., 9: 520-5(Mar. 1964). (In Russian)

The thermodynamic characteristics of $TaCl_5$ were analyzed and data on its vapor pressure during disproportionation at 377 to 413°C are tabulated. The following values were obtained: $\Delta H^0_T = 41.9 \pm 2$ kcal/mole, $\Delta S^0_T = 58.6 \pm 2$ entropy units. The crystal lattice of solid tantalum chlorides and the total energy of formation from free atoms in the vapor state were calculated. (R.V.J.)

**22069** SOLUBILITY OF LANTHANUM HYDROXIDES. P. N. Kovalenko and K. N. Bagdasarov (Rostov-on-Don State Univ., USSR). Zh. Neorgan. Khim., 9: 534-7(Mar. 1964). (In Russian)

The pH of the initial solubility (under equilibrium conditions) and precipitation of lanthanum hydroxides were determined using a photocolorimetric method. The photocolorimetric method was also used for determining microquantities of lanthanum by means of alizarin S. The molar coefficient for quenching colored solutions was equal to 6000 at $\lambda = 535$ m$\mu$. (R.V.J.)

**22070** NIOBIUM OXYCHLORIDE COMPOUNDS WITH SODIUM AND POTASSIUM CHLORIDES. S. A. Shchukarev, T. S. Shemyakina, and E. K. Smirnova. Zh. Neorgan. Khim., 9: 547-9(Mar. 1964). (In Russian)

Thermal decomposition of the binary compounds $NaCl \cdot NbOCl_3$, $KCl \cdot NbOCl_3$, and $2KCl \cdot NbOCl_3$ formed niobium oxytrichlorides. The vapor pressure of $NbCl_5$ over the solid binary compounds was measured. The data are used for determining the enthalpy and entropy of formation of binary compounds from the solid chlorides of alkali metals and niobium oxychloride vapor. (R.V.J.)

**22071** PENTARHODANIDE URANYL COMPLEXES. V. P. Markov, E. N. Traggeim, and I. M. Shul'gina (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 9: 550-4(Mar. 1964). (In Russian)

The preparation of the new uranyl complexes $(NH_4)_3UO_2 \cdot (NCS)_5 \cdot 2H_2O$, $K_3UO_2(NCS)_5 \cdot 2H_2O$; and $Cs(NH_4)_3[UO_2(NCS)_5]_2$ is described and their properties are studied. It is shown that the solubility, density, thermal stability, and indices of diffraction of the penta thiocyanato uranylate derivatives change regularly with the series of $NH_4$, K, $(CsNH_4)$, and Cs. (R.V.J.)

**22072** MIXED THORIUM CARBONATE–OXALATE COMPOUNDS. A. K. Molodkin and G. A. Skotnikova (Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 9: 555-61(Mar. 1964). (In Russian)

Mixed thorium carbonate-oxalate and hydroxycarbonate compounds were synthesized and their properties were studied. It is shown that oxalate groups are easily dislodged from the internal sphere by carbonate group complexes which have the tendency to coordinate around the central thorium atom. (R.V.J.)

**22073** A NEW COMPLEX OF TRIVALENT RHENIUM WITH THIOUREA. L. I. Evteev. Zh. Neorgan. Khim., 9: 606-7(Mar. 1964). (In Russian)

Preparation of a thiourea complex of trivalent rhenium $[Re(Thio)_4Cl_3 \cdot 6H_2O]$ is described. A hydrolysis scheme for the compound was studied. (R.V.J.)

**22074** ABSORPTION SPECTRA OF Nd, Er, AND Gd SOLVATES IN AQUEOUS AND ALCOHOL SOLUTION. I. I. Antipova-Karateva and Yu. I. Kutsenko. Zh. Neorgan. Khim., 9: 615-22(Mar. 1964). (In Russian)

Absorption spectra of Nd, Er, and Gd chlorides in water and in methyl and ethyl alcohol solutions were studied in the 220 to 1700 mμ spectral region. Certain changes observed in transitions from aqueous to alcohol solutions are related to the structure of solvates and their reaction with the electron shell in the central ion. Comparisons were made of the same ion in each multiplet in the spectra of various solutions and the variations of the multiplet in transition from aqueous solution to alcohol. (R.V.J.)

**22075** RARE EARTH CARBONATOFLUORIDES. Ya. D. Fridman and N. V. Dolgashova (Academy of Sciences, Kirgiz SSR). Zh. Neorgan. Khim., 9: 623-32(Mar. 1964). (In Russian)

Spectrophotometric studies of solutions containing praseodymium, neodymium, and erbium chlorides, potassium carbonates, and potassium fluorides revealed the presence of the complex carbonatofluoride ions $Pr(CO_3)_3F^{4-}$, $Pr(CO_3)_2F_2^{4-}$, $PrCO_3F_2^{3-}$, $Nd(CO_3)_2F_2^{3-}$, and $Er(CO_3)_2F_2^{3-}$. Possible reactions of formation of mixed compounds were analyzed and equilibrium constants were calculated. Solutions of $PrCO_3F \cdot 2H_2O$, $NdCO_3F \cdot 7H_2O$, $ErCO_3F \cdot 2.5H_2O$ were separated from Pr, Nd, and Er carbonatofluoride solutions. Thermal and optical crystal analysis indicated that the dehydration of the compounds resulted in anhydrous compounds of the general formula $MCO_3F$ and that decomposition of the carbonatofluorides into oxides takes place at 850°K. (R.V.J.)

**22076** SYNTHESIS OF SOLID-PHASE 6 BaO · $Nb_2O_5$. G. T. Andreeva and E. K. Keler. Zh. Neorgan. Khim., 9: 633-40(Mar. 1964). (In Russian)

The physicochemical properties of 6BaO · $Nb_2O_5$, prepared by reaction of $BaCO_3$ with $Nb_2O_5$, were studied. It is shown that an intermediate compound $5BaO \cdot 2Nb_2O_5$ is formed in the process. The compound $6BaO \cdot Nb_2O_5$ is stable at high temperatures (1300 and 1400°C) and has a melting point at 1930 ± 20°C. It is easily decomposed in air and in reaction with water. (R.V.J.)

**22077** PHASE EQUILIBRIUM AND CRYSTAL STRUCTURE OF Re–Fe(Co, Ni)–Si COMPOUNDS. E. I. Gladyshevskii, Yu. B. Kuz'ma, and D. A. Kovalik (L'vov State Univ., USSR). Zh. Neorgan. Khim., 9: 655-70(Mar. 1964). (In Russian)

Microstructure and x-ray diffraction analyses of the Re–Fe system (near $Re_3Fe_2$) showed that it forms a new intermetallic compound with a β-Mn type structure (a = 6.43 ± 0.01Å). Phase studies were made of Re–Fe(Co and Ni)–Si at 800°C and isothermal cross sections were constructed. Ternary intermetallic compounds in Re–Fe–Si and Re–Co–Si with $W_6Fe_7$ type structure were observed for the $Re_6Fe_6Si$ system: a = 4.67 ± 0.01 Å, c = 25.69 ± 0.05 Å, and c/a = 5.50, for $Re_6Co_{5.7}Si_{1.3}$; a = 4.633 ± 0.002 Å, c = 25.514 ± 0.005 Å, and c/a = 5.507. (R.V.J.)

**22078** PALLADIUM–TUNGSTEN–RHENIUM ALLOYS. M. A. Tylkina, V. P. Polakova, and E. M. Savitskii. Zh. Neorgan. Khim., 9: 671-3(Mar. 1964). (In Russian)

A constitution diagram was constructed for Pd–W–Re alloys and the properties of the alloys were analyzed. An increase in Re content lowered the melting point of the ternary alloy from the Pd–W side toward Pd–Re. An increase in Re content strongly increased the hardness of the alloy but it inhibited the alloy deformation at room temperature. Addition of Re to Pd–W alloys reduced the specific resistance and raised the temperature coefficient of the binary alloy. (R.V.J.)

**22079** $La_2O_3$–$HfO_2$ SYSTEMS. L. N. Komissarova, Ken-shih Wang, V. I. Spitsyn, and Yu. P. Semanov (Moscow State Univ.). Zh. Neorgan. Khim., 9: 693-7(Mar. 1964). (In Russian)

Thermal, x-ray phase analysis, and specific electric resistance measurements were taken of the system $La_2O_3$–$HfO_2$ at 1300 to 2450°C and a constitution diagram was constructed. The compound $La_2Hf_2O_7$ was formed in the system. The melting temperature for the compound was 2300 ± 30°. The x-ray phase analysis established one- and two-phase regions of $La_2Hf_2O_7$ with $HfO_2$ and $La_2O_3$. (R.V.J.)

**22080** POTASSIUM, ZIRCONIUM AND BORON OXIDE–FLUORIDE SYSTEMS. P. A. Polishchuk (Dnepropetrovsk Chemical and Technological Inst., USSR). Zh. Neorgan. Khim., 9: 705-8(Mar. 1964). (In Russian)

Melt diagrams constructed for the systems KF, $KBF_4$, $K_2ZrF_6$, and $B_2O_3$ showed with others a thermally stable compound $K_3ZrF_7$. The melting point of the system formed by $ZrO_2$ and $KBF_4$ is shown as a function of the analytical and virtual composition of alloys. The melt diagram also indicated two stages in $ZrO_2$ and $KBF_4$ reaction. (R.V.J.)

**22081** ELECTRIC CONDUCTIVITY OF ZIRCONIUM OXYCHLORIDE IN ORGANIC SOLVENTS. O. A. Osipov, O. E. Kashireninov, and A. V. Leshchenko (Rostov-on-Don State Univ., USSR). Zh. Neorgan. Khim., 9: 734-7(Mar. 1964). (In Russian)

Electric conductivity of niobium hydroxide in organic solvents (methyl, n-butyl, and heptyl alcohols, nitrobenzene, and pyridine) was measured as a function of concentration and temperature. It was revealed that the electric conductivity of $NbOCl_3$ solutions depends on its chemical nature in addition to the dielectric penetrability of the solvent. The

dipole moment of $NbOCl_3$ in dioxane is 4.80 ± 0.1D. The data are analyzed as a chemical reaction between $NbOCl_3$ and solvents. (R.V.J.)

**22082** $Li_2SO_4-Cs_2SO_4-PbSO_4$ SYSTEM. I. N. Belyaeva and N. N. Chikova. Zh. Neorgan. Khim., 9: 756-8(Mar. 1964). (In Russian)

Visual-polythermal method was used for studying the ternary system $Cs_2SO_4-PbSO_4-Li_2SO_4$. Three eutectic points and one peritectic point were revealed. (R.V.J.)

**22083** ON CUBICAL MODIFICATION OF BERYLLIUM OXIDE. F. Sh. Muratov and K. N. Semenenko (Moscow State Univ.). Zh. Neorgan. Khim., 9: 765-6(Mar. 1964). (In Russian)

X-ray diffraction analysis indicated a reversible beryllium oxide phase transition from hexagonal modification into cubical at ~2000°C. The cubical modification observed at 2000°C could not be stabilized by quenching. The intraspatial distances in beryllium oxide cubical modifications for various phases were correlated. It was noticed that in suspension the cubical modification of beryllium oxide appears at lower temperatures than previously established (2000°C). (R.V.J.)

**22084** X-RAY ANALYSIS OF SCANDIUM IODIDE. A. A. Men'kov and L. N. Komissarova. Zh. Neorgan. Khim., 9: 766-7(Mar. 1964). (In Russian)

Scandium iodide was prepared and was found to crystallize in a rhombohedral lattice of the following parameters: a = 7.939 ± 0.005 kX, a = 53°25' ± 5', z = 2 kX, c/a = 2.85, and z = 6. The $ScI_3$ structure is identical to $FeCl_3$ and can be described by the fedorovite group $R\bar{3}(C_{3i}^1)$. The x-ray diffraction density of $ScI_3$ is 4.70 and pycnometric density is 4.63 g/cm³. (R.V.J.)

**22085** SOLVATION OF $UCl_4$ BY TRI-N-BUTYLPHOSPHATE MOLECULES. A. A. Lipovskii and N. E. Yakovleva. Zh. Neorgan. Khim., 9: 767-8(Mar. 1964). (In Russian)

The composition and structure of $UCl_4$ solvates was studied using electron absorption spectra of anhydrous $UCl_4$ in TBP solution in $CCl_4$. The composition of the solvates formed was determined by variations of absorption band molar coefficient of extinction as a function of TBP concentration. The strongest variations were observed at $\lambda$ = 453 mμ and $\lambda$ = 666 mμ. The data treated according to the Bent-French method showed formation of the solvate $UCl_4 \cdot 3TBP$. The equilibrium constant of the reaction $UCl_4 \cdot 2TBP + TBP \rightleftharpoons UCl_4 \cdot 3TBP$ was equal 45 ± 2.0. The infrared absorption spectra confirmed the presence of two solvates for $UCl_4$ and TBP. It was postulated that $UCl_4$ solvation by other neutral phosphoroörganic compound molecules forms more than one solvate with two TBP molecules. (R.V.J.)

**22086** REACTION OF GRAPHITE WITH CARBON DIOXIDE AT 1000°C TO 1600°C UNDER FLOW CONDITIONS. E. A. Gulbransen, K. F. Andrew, and F. A. Brassart (Westinghouse Electric Corp., Pittsburgh). 23p. (CONF-73-24)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

The reaction of high purity graphite in carbon dioxide was studied at a pressure of 19 torr using flow rates up to $1.8 \times 10^{20}$ molecules of carbon dioxide per second through the furnace tube. Below 1350°C gas diffusion effects were eliminated by the use of small samples and high flow rates, and the reaction followed a chemical controlled reaction mechanism with a heat of activation of 88 kcal per mole. Above 1400°C a gas diffusion controlled mechanism was found for all flow rates. A desorption mechanism was proposed for the chemical controlled region of reaction. (auth)

**22087** RECENT DEVELOPMENTS IN RARE EARTH MÖSSBAUER STUDIES. S. G. Cohen, I. Nowik, and S. Ofer (Hebrew Univ., Jerusalem). 23p. (CONF-303-17)

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

Experiments using rare earth iron garnets ($5Fe_2O_3 \cdot 3M_2O_3$) as absorbers in recoil-free resonance absorption measurements are described. Results of experiments on effective magnetic fields acting on the nucleus of Dy, Eu, and Tm in iron garnets and hyperfine interactions in the $2^+$ rotational level of $^{180}Dy$ in Dy iron garnet are discussed. Good agreement between experimental and theoretical values of $H_{eff}$ was found. Data are tabulated. (P.C.H.)

**22088** ON THE QUESTION OF ISOTOPIC PHASE SEPARATION IN SOLID $H_2-D_2$ MIXTURES. J. G. Daunt (Ohio State Univ., Columbus). 17p. (CONF-481-12)

From American Physical Society Annual Meeting, New York, Jan. 1964.

The possible isotopic phase separation in solid $H_2-D_2$ mixtures was investigated by observation of line widths and line shapes of nuclear resonance. Nuclear resonance signals from protons in solid $H_2-D_2$ mixtures were studied above 10°K by means of a pulsed MNR spectrometer and below 10°K by means of a modified Pound-Watkins spectrometer with a lock-in amplifier. No evidence for a composite resonance line was observed experimentally in the range 3 to 16.4°K. Instead, all NMR lines were approximately single Gaussians. It was found that the ratio of the intensity of the central portion of the line to the intensity of the wings increased as the r-f level increased. By thermal cycling of the temperature between 1.1 and 3°K, it was found that the transition from a single line, as observed above 3°K, to a composite line shape occurred relatively quickly, in a time less than 2 min. It was concluded that the results were not conclusive enough to be interpreted as due to isotopic phase separation. (P.C.H.)

**22089** METHOD FOR THE PREPARATION OF A SUSPENSION OF THORIUM OXIDE IN A LIQUID METALLIC BASE MASS. Allan Brown and Anthony Chitty (to General Electric Co. Ltd.). German Patent 1,160,191. Dec. 27, 1963. Priority date Jan. 20, 1959, Great Britain.

The thorium suspension, the preparation of which is described, is used as fertile material in reactors. The method comprises the steps of resolving thorium metal in a metallic melt, of mixing the base alloy obtained in this manner with an oxide that is wetted by the melt and is less stable than the thorium oxide, and of stirring the mixture violently while heating it to a temperature at which the base mass is kept liquid. (Gmelin Inst.)

**22090** METHOD FOR THE PREPARATION OF PURE SODIUM BY FUSION ELECTROLYSIS. Wilford Harold Thomas (to Ethyl Corp.). German Patent 1,162,575. Feb. 6, 1964. Priority date Dec. 21, 1959, United States.

A method is described for the preparation of pure sodium by fusion electrolysis of a salt melt containing strontium chloride and sodium chloride. It is proposed to use a molten electrolyte, which consists of 80 to 65% strontium chloride and 20 to 35% sodium chloride. The method is preferably carried out at a temperature between 565 and 590°C. (Gmelin Inst.)

**22091** ION EXCHANGE. Pierre Cohen and Rene Amavis (to Commissariat à l'Energie Atomique). U. S.

Patent 3,128,247. Apr. 7, 1964. Priority date Nov. 16, 1959, France.

The ion-exchange process described utilizes a mixture of a powder of basic hydrated lead sulfate and a powder of an inert material. The lead sulfate operates as an anion exchanger in acid media and as cation exchanger in basic media. In acid media, the anion exchange capacity increases as the pH decreases; in basic media, the cation exchange capacity increases as the pH increases. The anion exchange capacity is substantially the same for the anions $Cl^-$, $SO_4^-$, and $NO_3^-$. The cation exchange capacity depends on the nature of the cation. Fixation of the ions is reversible. The lead sulfates are stable at high temperatures and in the presence of radiations. (A.G.W.)

**22092** PROCESS FOR PRODUCING RARE EARTH SELENIDES AND TELLURIDES. Hubert M. Muir (to Nuclear Corp. of America). U. S. Patent 3,129,056. Apr. 14, 1964. Filed Apr. 1, 1960.

A gadolinium selenide compound may be prepared by sealing Gd and Se in divided form in a chamber containing an inert gas at a pressure materially below atmospheric and slowly raising the temperature of the chamber over a period of several hours to generate vapors and cause a controlled and non-explosive reaction between the elements. The temperature of the chamber is maintained for a time sufficient to materially complete the reaction and then gradually lowered. The resulting powdered reaction product is removed from the chamber, homogenized, and pressed into pellets. The pellets are arc melted in an inert atmosphere. Tables showing the composition, density, melting point, and Seebeck coefficient of the compound are included. The procedure may also be used to prepare selenides and tellurides of other rare earth metals. (A.G.W.)

## Organic Chemistry

**22093** (UCRL-11184(p.110-12)) OSMIUM TETROXIDE–TRIGLYCERIDE INTERACTION AS A FUNCTION OF DEGREE OF UNSATURATION. AN X-RAY FLUORESCENCE STUDY. Thomas L. Hayes and James N. Hawkins (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

A quantitative determination of the amount of osmium found in triglycerides, following a one-half-hour reaction with 1% buffered osmium tetroxide, has shown that the amount of osmium is approximately proportional to the number of double bonds found in the molecule. (auth)

**22094** PREPARATION OF 2- $^{13}C$, 3- $^{13}C$ AND $^{15}N$ ENRICHED PYRROLES. CONVERSION OF FURAN TO PYRROLE. Boerge Bak, Thorvald Pedersen, and Georg Ole Soerensen (Universitet, Copenhagen). Acta Chem. Scand., 18: 275-6(1964).

In order to get further information on the molecular structure of pyrrole by microwave investigation of isotopically substituted species, small quantities of 2-$^{13}C$, 3-$^{13}C$, and $^{15}N$ enriched pyrroles were prepared. Labeled furans were converted into the corresponding pyrroles by the action of gaseous $NH_3$ and a catalyst. $^{15}N$ enriched pyrrole was prepared by the pyrolysis of the ammonium salt of mucic acid $(CHOH)_4(COO^*NH_4)_2$, enriched to 33% in $^*N$. Each of the preparation methods is described. (P.C.H.)

**22095** THE STABILITY OF SOME LANTHANIDE COMPLEXES WITH METHYLETHYL GLYCOLATE AND WITH METHYLPROPYL GLYCOLATE. L. Eeckhaut, F. Verbeek, H. Deelstra, and J. Hoste (Universitè, Ghent). Anal. Chim. Acta, 30: 369-76(Apr. 1964).

Four successive stability constants were determined for the methylethyl glycolate and methylpropyl glycolate complexes of some lanthanide elements by potentiometric titration. For all the metal ions, except lanthanum, the average ligand number exceeds a value of 3 indicating the formation of uninegative tetra-ligand complexes, $ML_4^-$. The stability constants are close to the values of the corresponding $\alpha$-hydroxyisobutyrate complex systems. (auth)

**22096** RADIOACTIVE LABELING OF TROPANE ALKALOIDS. II. SYNTHETIC INCORPORATION OF $C^{14}$ IN (-)-COCAINE, (-)-ECGONINE, AND DERIVATIVES. Hanns-Ludwig Schmidt and Gottfried Werner (Max-Planck-Institut für Hirnforschung, Marburg, Ger.). Ann. Chem., 653: 184-94(1962). (In German)

Cocaine was specifically labeled by the following routes. Oxidation of O-benzoyl-(-)-ecgonine with $KMnO_4$ gave O-benzoyl-nor-(-)-ecgonine, which was converted to nor-(-)-cocaine in methanolic HCl. This was methylated with $^{14}CH_3I$, yielding (-)-cocaine-(N-$^{14}CH_3$) hydrochloride after conversion to the free base. The yield is 71%, activity 4.5 mC/mmole. The infrared spectra of (-)-cocaine and nor-(-)-cocaine are published for use in quantitative estimations of mixtures. Treatment of ecgonine methyl ester with benzoyl chloride-carbonyl-$^{14}C$ yielded (-)-cocaine-($C_6H_5{}^{14}CO$) in 63% yield, activity 0.64 mC/mmole; separation of the products was effected by extraction into ether from a 10% ammonium carbonate solution, the weaker base, cocaine, being extracted this way. In the preparation of (-)-cocaine-(O-$^{14}CH_3$), precise directions for the preparation of $^{14}CH_2N_2$ from $Na^{14}CN$ are given, with $^{14}CH_3NH_2 \cdot HCl$ and nitrosomethylurea-N-$^{14}CH_3$ as intermediates. The labeled diazomethane was reacted with O-benzoyl-(-)-ecgonine to yield (-)-cocaine-(O-$^{14}CH_3$) in 49.5% yield, activity 0.62 mC/mmole. Ester interchange of (-)-cocaine-(N-$^{14}CH_3$) in methanolic HCl gave (-)-ecgonine methyl ester-(N-$^{14}CH_3$) in 35% yield, activity 0.17 mC/mmole. Acid (HCl) hydrolysis of this yielded (-)-ecgonine-(N-$^{14}CH_3$) in 96% yield, activity 0.18 mC/mmole. The action of benzoic anhydride on the latter gives O-benzoyl-(-)-ecgonine-(N-$^{14}CH_3$) in 44% yield, activity 0.17 mC/mmole. Proof of purity of the samples was determined by radiopaper chromatography, electrophoresis, and infrared spectra. An apparatus for methylation with $^{14}CH_3I$ is illustrated and described. (BBB)

**22097** RADIOACTIVE LABELING OF TROPANE ALKALOIDS. III. PREPARATION OF $H^3$-ATROPINE AND $H^3$-NOR-(-)-COCAINE. DESCRIPTION OF AN APPARATUS FOR TRITIATION WITH $H_2^3$ GAS. Hanns-Ludwig Schmidt and Gottfried Werner (Max-Planck-Institut für Hirnforschung, Marburg, Ger.). Ann. Chem., 656: 149-57(1962). (In German)

Atropine was exposed to 2 C $^3H_2$ for 16 days in a sealed glass ampoule. The sample was dissolved twice in methanol and the methanol distilled off; recrystallization of the atropine from ligroine gave a product containing two products, one of which was radioactive. This could be removed either by two sublimations or by chromatography over a cellulose column. Paper chromatography indicated that preparations made under the influence of a Tesla discharge were almost exclusively decomposition products of atropine. Samples placed in the shadow of the discharge showed less decomposition but less $^3H$ incorporation. Nor-(-)-cocaine was labeled and purified in the same way, the final activity being 8.7 $\mu$C/mg after 33 days exposure, as

opposed to 50-60 μC/mg for highly purified atropine samples prepared as above. Since special apparatus for handling $^3H_2$ samples is demanded by the small volume of active samples (5C = 2 ml gas), a special apparatus is illustrated and described at length which is based in part on a combination of earlier techniques. A detailed explanation of the use of the apparatus is also given. The technique involves capillary transfer of $^3H_2$ samples and fixation by pyrophoric U until the organic sample is introduced into the apparatus, when $^3H_2$ is released by pyrolysis at temperatures not above 380°C. (BBB)

**22098** SYNTHESIS OF TESTOSTERONE-19-$^{14}$C. P. Narasimha Rao and L. R. Axelrod (Southwest Foundation for Research and Education, San Antonio, Tex.). Chem. Ind. (London), No. 46, 1838-9(Nov. 1963).

Prior to determination of the fate of the C19 unit in the aromatization mechanism of androgens, the synthesis of testosterone-19-$^{14}$C was carried out as follows. Ozonolysis of 19-nortestosterone-17 β-acetate, followed by alkaline hydrolysis gave 17 β-hydroxy-5-oxo-3,5-seco-4-norestrane-3-oic acid (I). Condensation of the keto acid (I) with ethyl formate in the presence of Na methoxide in a mixture of benzene-tetrahydrofuran solution gave 17 β-hydroxy-5-oxo-6-hydroxymethylene-3,5-seco-4-norestrane-3-oic acid (II). By condensation with methylaniline in methanol solution the hydroxymethylene compound (II) was converted to the methylanilinomethylene ketone which was esterified with diazomethane and chromatographed on aluminum oxide to give 17 β-hydroxy-5-oxo-6-methylanilinomethylene-3,5-seco-4-nor-3-methyl estranoate (III). The C19 methyl group was then introduced into III following the angular methylation procedure: III was caused to react with methyl iodide in tert-butanol in the presence of K tert-butoxide and the crude reaction product was hydrolyzed first by acid and then with base to remove the methylanilinomethylene blocking group. From the reaction mixture 17 β-hydroxy-5-oxo-3,5-seco-4-norandrostane-3-oic acid (IV) crystallized out. The keto acid (IV) was then converted into testosterone through the intermediate enol lactone, at 20°C with 2M acetic anhydride–ethyl acetate–perchloric acid reagent for exactly 2 min to obtain 17 β-acetoxy-5-hydroxy-3,5-seco-4-nor-5-androstene-3-oic acid, 3,5-lactone. In the radiosynthesis step, 27 mC of methyl-$^{14}$C iodide was caused to react with III to give ultimately testosterone-19-$^{14}$C with a specific activity of 3.97 μC/mg. The overall yield of testosterone-19-$^{14}$C from III, based on the steroid, was 4%. (BBB)

**22099** RESULTS IN THE LABELING OF HIPPURAN WITH I-131. Seppo Niklander. Duodecim, 79: 552-6 (1963). (In Finnish)

A modification of the labeling technique allows the preparation of the radioiodinated drug at 1/20 its commercial cost. (BBB)

**22100** A STUDY OF 2-HYDROXY-3-NAPHTHOIC ACID DERIVATIVES OF THORIUM AND ZIRCONIUM. R. P. Agarwall and R. C. Mehrotra (Univ. of Gorakhpur, India). Indian J. Chem., 2: 138-41(1964).

Complexation reactions of thorium and zirconium with 2-hydroxy-3-naphthoate ions were studied by precipitation, potentiometric, and conductometric techniques. The studies indicate that in acidic solutions the 1:2 complex of thorium is precipitated by the addition of sodium 2-hydroxy-3-napthoate to a thorium nitrate solution and on neutralization with a base changes into the 1:1 complex. Similar studies with zirconium indicate the formation of 1:1 complex only. (auth)

**22101** FORMATION CONSTANTS OF THE RARE EARTH GLYOXYLATE COMPLEX SPECIES. J. E. Powell and Y. Suzuki (Iowa State Univ., Ames). Inorg. Chem., 3: 690-2(May 1964). (IS-767)

Stabilities of the first three complex species formed between tripositive rare earth cations and the glyoxylate anion were measured at an ionic strength of 0.10 at 20°C by a method involving potentiometric determination of the pH of glyoxylic acid-sodium glyoxylate buffer solutions containing rare earth perchlorates and sodium perchlorate. It was ascertained that rare earth glyoxylate species are more stable than the corresponding acetate species, but are less stable than the corresponding glycolate species. Yttrium forms glycolate species, which are slightly less stable than those formed by dysprosium. (auth)

**22102** THE EFFECT OF THE ISOTOPIC EXCHANGE OF THE OXYGEN ATOM ON THE ABSORPTION INTENSITY OF THE VIBRATION BANDS OF BENZOPHENONE. I. Laulicht and S. Pinchas (Weizmann Inst. of Science, Rehovoth, Israel). Israel J. Chem., 1: 404-8(Dec. 1963).

According to theory the sum of the integrated intensities of all absorption bands of a species, divided over the square of their respective frequencies should, under certain conditions, be independent of the isotopic constitution of the vibrating molecule. It was observed that of all the benzophenone bands in the 3500-370 $cm^{-1}$ region only the C = O stretching frequency at 1667 $cm^{-1}$ and its C = O bending vibration at 640 $cm^{-1}$, shifted significantly as a result of labeling with $^{18}O$; hence only the absorption intensity of these seems to be affected by this exchange. The planimetrically integrated intensity of the 1637 $cm^{-1}$ C = $^{18}O$ stretching band, measured under a resolution of 1/10th of its half-width, was found to be about 25% less than of the corresponding C = $^{16}O$ band. This decrease is not balanced by the tiny increase in the intensity of the 640/637 $cm^{-1}$ band and disagrees with the theoretically expected value. (auth)

**22103** ISOTOPE EFFECTS FOR SOLVOLYSIS OF t-BUTYL CHLORIDE AND t-BUTYL-$d_9$ CHLORIDE IN SOLVENT MIXTURES OF CONSTANT IONIZING POWER. Gino J. Frisone and Edward R. Thornton (Univ. of Pennsylvania, Philadelphia). J. Am. Chem. Soc., 86: 1900-1 (May 5, 1964).

Isotope effects were determined for the solvolysis at 25°C of $(CH_3)_3CCl$ and $(CD_3)_3CCl$ in six solvent mixtures each having the same Y-value (by definition), the same reaction rate for $(CH_3)_3CCl$. It was concluded that the structural features of the transition states for solvolysis of t-butyl chloride in the various solvents studied were very similar. Three hypotheses that explain these observations are discussed. The constancy of the isotope effects seems to indicate that the activation process is remarkably insensitive to the presence of solvent species of widely variable electrophilic and nucleophilic properties. Data are tabulated. (P.C.H.)

**22104** COLLISIONAL DEACTIVATION OF VIBRATIONALLY EXCITED ETHYL-$d_3$ RADICALS BY $D_2$ AND He. J. H. Current and B. S. Rabinovitch (Univ. of Washington, Seattle). J. Chem. Phys., 40: 2742-3(May 1, 1964).

The collisional deactivation of ethyl-$d_3$ radicals activated by the process, trans-$C_2H_2D_2$ + D → $CHDCHD_2$* was studied. The results showed that the ratio of inert:ethylene varied from 8:1 to 35:1 on a collision number basis and was usually in the range 12–15:1. The relative collisional efficiencies were measured. It was concluded that the collisional deactivation efficiency of inert gases varies

with the system of interest and is relative to the operational definition of efficiency; in the systems studied, the efficiency increases with decrease in the energy degradation range. (P.C.H.)

**22105** SYNTHESES OF BENZENE-$^{14}C_6$ AND BENZENE-$^{2}H_6$ USING A ZIEGLER-CATALYST. Sakuji Ikeda and Akihiro Tamaki (Tokyo Inst. of Tech.). Radioisotopes (Tokyo), 12: 368-72(Nov. 1963). (In Japanese)

By a low-pressure reaction of acetylene with an appropriate Ziegler catalyst at room temperature, benzene is obtained in about 70% yield. Polyacetylene is the only appreciable by-product, and the benzene can be liberated by pumping out through a dry ice–methanol trap, together with dry nitrogen introduced from a capillary tube inserted into the reaction mixture. This reaction was applied to syntheses of benzene-$^{14}C_6$ and benzene-$^{2}H_6$. Most of the manipulations can be carried out in a vacuum system and are less laborious than the several methods previously reported, which utilize rather uncommon starting materials, other than the Reppe process, which utilizes acetylene as a starting material but requires high pressure and high temperature. Respective comparisons of the specific activity (μc/g atom C) and the $^{2}H$-content of the benzenes with those of corresponding acetylenes showed that they were in good agreement with each other. This fact seems to suggest that, during the trimerization, neither carbon nor hydrogen from other substances than the acetylene can be introduced into the benzene. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**22106** THE INTRODUCTION OF DEUTERIUM INTO THE C-19 ANGULAR METHYL GROUP. Carl Djerassi and M. A. Kielczewski (Stanford Univ., Calif.). Steroids, 2: 125-34(Aug. 1963).

By the use of 19-hydroxy-$\Delta^5$-steroids, methods were developed for introduction of one or three D atoms into the C-19 angular methyl group to afford labeled substrates suitable for mass spectrometric studies. The starting material for deuteriated steroids was $\Delta^5$-androstene-3β,19-diol-17-one-3-acetate, which is readily accessible from dehydroisoandrosterone. Since, for ultimate mass spectrometric studies, ring D unsubstituted steroids were required, the starting ketone was transformed into the thioketal and desulfurized with W-2 Raney nickel catalyst to afford the key intermediate $\Delta^5$-androstene-3β,19-diol 3-acetate. Conversion to the 19-mesylate and displacement with lithium bromide in isopropyl alcohol solution provided the oily 19-bromide, which was reduced with lithium aluminum deuteride to 19-d-$\Delta^5$-androsten-3β-ol. Catalytic hydrogenation followed by oxidation with chromium trioxide led to the required 19-d-5α-androsten-3-one. For the introduction of three D atoms, a more cumbersome route had to be developed starting with the 19-carboxylic acid, which was most conveniently prepared by chromium trioxide-pyridine oxidation of $\Delta^5$-androstene-3β,19-diol 3-acetate to the aldehyde, followed by treatment with potassium permanganate in pyridine solution. Lithium aluminum deuteride reduction of the 19-carboxylic acid to 19-$d_2$-$\Delta^5$-androstene-3β,19-diol resulted in introduction of 2 D atoms and it was now only necessary to protect the free 3-hydroxyl function to permit application of the same sequence employed earlier to insert the remaining D atom. For this purpose, the diol was diacetylated and then partially saponified at C-3 to provide the 3β-hydroxy-19-acetate. The latter was transformed into the tetrahydropyranyl ether and directly saponified to the 19-hydroxy 3β-tetrahydropyranyl ether. The remaining steps followed well-known steps involving 19-mesylate formation, displacement with lithium bromide and accompanying cleavage of the tetrahydropyranyl ether protective grouping, lithium aluminum deuteride reduction, and finally catalytic hydrogenation and oxidation at C-3 to yield 19-$d_3$-5α-androstan-3-one, the isotopic composition of which was established by mass spectrometry. (BBB)

**22107** A SYSTEMATIC STUDY OF INITIAL ENERGY IN THE UNIMOLECULAR DECOMPOSITION OF PARAFFIN IONS. R. Fuchs and R. Taubert (Physikalisch-Technische Bundesanstalt, Braunschweig, Ger.). 6p. (CONF-296-5)

From Symposium on Unimolecular Reactions in the Mass Spectrometer and Related Topics in Chemical Kinetics, Salt Lake City, July 1963.

The results of electron impact experiments on the kinetic energy of fragment ions from methane, ethane, propane, butane, and some pentane and hexane ions are discussed. The results are condensed into empirical rules, which are listed and discussed. Assumed reactions for some of the hydrocarbons are given. (P.C.H.)

## Radiation Chemistry and Radiochemistry

*Refer also to abstracts 21871 and 22351.*

**22108** (CONF-179-3) RADIOLYSIS OF ION EXCHANGE RESINS USED IN THE PURIFICATION SYSTEMS OF SAVANNAH RIVER REACTORS. Elizabeth W. Baumann (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 23, 1964. Contract AT(07-2)-1. 7p.

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

The problem of resin radiolysis in reactor coolant systems was studied. The radioactivity of the $D_2O$ in Savannah River reactors is comprised of both fission products and neutron-activation products. The resin beds retain more than 90% of the radioactivity. Estimates indicated that $^{24}Na$ is the major contributor to the dose and that the total dose is greater than $10^7$ rad. Short-lived isotopes were not included in the estimate. It was found that long-term exposure to radioactivity inherent in reactor coolant purification systems may result in radiation damage to deionizing resins. (M.C.G.)

**22109** (CONF-322-8) PRODUCTION OF THE OXYGEN 5577 Å EMISSION BY POLONIUM-210 ALPHA RADIATION. S. Dondes, P. Harteck, and C. Kunz (Rensselaer Polytechnic Inst., Troy, N. Y.). [1963]. Contract AT(30-3)-321. 24p.

From the American Chemical Society, Production Technology of Np-237 and Pu-238, Denver, Jan. 1964.

The presence of the forbidden auroral green line of atomic oxygen ($^1S \rightarrow {}^1D$) at 5577 Å in the spectra resulting from the irradiation of purified nitrogen containing small amounts of oxygen is reported and discussed. The line emission is associated with a continuum. The high intensity of the emission requires that it be initiated by a species formed at a high yield and by a process of high efficiency. The intensity of the emission increases when the temperature is lowered and therefore all reactions involved in producing this emission cannot have a heat of activation over 1 kcal. An electric field substantially quenches the light emission indicating that an ion mecha-

nism is involved. When the oxygen concentration is increased to 3 parts per ten thousand or over, the OI emission is completely quenched. It was concluded that the reaction is $N^+ \rightarrow O_2 \rightarrow NO^+ + O('S)$, 6.6 ev. (P.C.H.)

**22110** (NRS-11) IODINE AS A SCAVENGER FOR HYDROGEN ATOMS IN IRRADIATED ETHANOL. N. T. Barker and J. H. Green (New South Wales, Australia. Univ., Kensington). 1964. 9p.

Data on hydrogen yields in radiolysis of alcohols are presented. Iodine scavenging of hydrogen ions in irradiated ethanol was studied. The HI produced was determined by measuring the change in resistance of irradiated solutions of iodine in ethanol. (M.C.G.)

**22111** (ORNL-3591(p.16-37)) RADIATION CHEMISTRY OF THE MSR SYSTEM. (Oak Ridge National Lab., Tenn.).

Postirradiation examination of the several capsules from three in-pile tests of MSRE fuel-graphite-metal compatibility continued to furnish evidence of evolution of $F_2$ and $CF_4$, graphite damage, and other potentially unfavorable phenomena. All cases of unusual behavior, however, seemed to be consequences of $F_2$ generation at low temperatures under conditions that will not normally exist in MSRE. Radiolytic formation of $F_2$ at temperatures below 100°C was observed over a 5-month interval in two capsules that were fitted for sampling of the evolved gases. Fluorine release proceeded at a maximum rate near room temperature (G = 0.01 to 0.02 molecule of $F_2$ per 100 ev absorbed) and decreased to zero rate at −70 and +80°C. At the low temperature, slow diffusion in the crystals presumably limited the evolution rate, while at high temperatures the back reaction of radiolytic products appeared to be controlling. Deliberate addition of $F_2$ produced results that confirmed this picture and that demonstrated that $F_2$ reacts more rapidly with salt that has previously lost most of its $F_2$ by radiolysis. These observations conclusively eliminated the specter of fluorine generation at reactor operating temperatures. In reactor components such as freeze valves or freeze flanges, and in tanks for storage of irradiated salt, however, the temperature must be kept high enough (200°C seems sufficient) to prevent salt radiolysis. Chemical analyses of graphite cores from the large capsules of one assembly revealed the presence of appreciable (0.1 to 0.5% by weight) quantities of uranium, as well as molybdenum, lithium, and container metals. Autoradiography, before and after neutron activation, and x radiography of transverse sections of the cores showed that the uranium was present in a 2-mil-thick layer on the surface of the specimens. Neutron activation analyses gave slightly lower results for uranium than obtained by chemical analyses. The deposition of uranium was probably a consequence of fuel radiolysis during reactor shutdowns in the course of the in-pile exposure. To test this conjecture, the design of the current in-pile experiment (47-6) provides for heaters on each capsule to prevent radiolysis during shutdown. Salient features of the fluorine generation and recombination processes were verified with simulated MSRE fuels, and with some of the component fluorides, on exposure to pure gamma, beta, and x radiation. An INOR-8 capsule containing MSRE salt and graphite was exposed to gamma radiation from a $^{60}Co$ source for ~7400 hr at temperatures ranging from 38 to 150°C. The salt received a calculated $0.45 \times 10^{20}$ ev $hr^{-1}$ $g^{-1}$. After an induction period of about 600 hr, fluorine gas was generated at rates (G values) varying between 0.03 to 0.07 molecule of fluorine per 100 ev absorbed at temperatures up to 110°C. At 150°C any fluorine gas generated previously was recombined. At 130°C recombination rates roughly equaled generation rates. No evidence of any appreciable reaction of the $F_2$ gas with the graphite to generate $CF_4$ was obtained. Experiments to investigate fluorine evolution from studies of behavior of solid MSRE fuel mixtures under fast electron bombardment yielded values of $G_{F_2}$ as a function of dose up to a total dose of about $1.6 \times 10^{18}$ Mev per g of salt. At doses below about $8 \times 10^{17}$ Mev/g, maximums in the fluorine production rates were observed or indicated in each experiment. In one of the experiments exposed to a greater dose, a second increase in fluorine evolution rate was observed after a total dose of about 9 to $10 \times 10^{17}$ Mev/g. It was observed that reduction of the dose rate by a factor of about 2 causes an increase in the initial rates of fluorine evolution per unit dose ($G_{F_2}$). The maximum $G_{F_2}$ observed was 0.02. Similar experiments with solid LiF showed that fluorine was not evolved as a result of bombardment with fast electrons but was taken up in small amounts. Soft x-ray irradiation of a solid mixture similar to the MSRE fuel gave evidence of radiolytic decomposition with yields of volatile fluorine compounds equivalent to $G_{F_2}$ (moles $F_2$ per 100 ev absorbed) values ranging from 0.0006 to 0.04. In some cases elemental fluorine was identified, but, generally, the products were carbon tetrafluoride and carbonyl fluoride. Prefluorination of the salt removed carbon-containing impurities and encouraged liberation of elemental fluorine. Fine particles liberated volatile fluorine-containing products at about ten times the rate from coarse particles. The compound $6LiF \cdot BeF_2 \cdot ZrF_4$, one of the complex compounds which crystallize from the MSRE fuel, decomposed with an equivalent $G_{F_2}$ of about 0.02. Prefluorinated thorium fluoride liberated elemental fluorine at rates of about 0.005 molecule per 100 ev. Neither lithium nor zirconium fluorides gave any evidence of radiolysis. (auth)

**22112** (ORNL-3591(p.185-90)) BEHAVIOR OF RADIOIODINE. (Oak Ridge National Lab., Tenn.).

An investigation was made of the origin, identity, and behavior of iodine compounds which appear when air and iodine vapor are mixed. Information is needed on these points in order to design radioiodine removal systems. Rates of deposition of iodine compounds were measured by use of successive diffusion tubes having surfaces of silver, rubber, and activated carbon. Elemental iodine deposited on the silver with its characteristic diffusion coefficient of about 0.08 $cm^2$/sec; a compound or group of compounds deposited on the rubber to give an indicated diffusion coefficient of about 0.05 $cm^2$/sec, suggestive of a molecular weight of the order of 300 or higher; other iodine materials deposited on the activated carbon to yield a diffusion coefficient of 0.10 $cm^2$/sec, implying a molecular weight somewhat lower than that of $I_2$. This behavior was typical of iodine from two greatly differing sources. As the iodine concentration in air decreased, the proportion of iodine present in forms other than molecular iodine increased. The sorption characteristics of fission products are of significance in predicting their deposition behavior in flowing gas systems. The adsorption of iodine on commonly used stainless steels was explored with metal temperatures ranging from 24 to 700°C and with iodine vapor concentrations varying from 0.0004 to 2200 mg/$m^3$. Iodine vapor was found to react chemically with stainless steel surfaces to form metal iodides. The capacity of the surface varied with the condition of the adsorbing surface. Passivity towards iodine adsorption was frequently observed after a small amount of material was sorbed. The kinetics of the chemisorption process also varied, apparently with

changing surface conditions, even during the course of a single experiment. The iodine sources used were analyzed for forms other than $I_2$. Methyl iodide was found, but it constituted less than 0.1% of the total iodine. Fractional sublimation of the iodine sources in vacuum ensured that only $I_2$ was used in the adsorption experiments. Charcoal traps remove molecular iodine from gases with a high degree of efficiency, but they are susceptible to destruction when exposed to oxidizing gases at high temperatures, conditions which could conceivably exist in a reactor accident. Preliminary experiments to explore alternate trapping materials indicated that a bed of platinized alumina (a hydroforming catalyst) would serve only to delay the passage of iodine when the bed is exposed to flowing air at temperatures above 400°C. Trapping of radioiodine by high-temperature exchange with nonradioactive iodine in a bed of potassium iodide appeared to be feasible up to temperatures at which significant oxidation of the inorganic iodine occurs (600°C or higher). (auth)

**22113** (ORNL-3591(p.223-30)) EFFECTS OF RADIATION AND HEAT ON ORGANIC MATERIALS. (Oak Ridge National Lab., Tenn.).

A dosimeter that consists of a dilute solution of $C_{10}H_{22}$ and $C_2H_2Cl_4$ in $C_8F_{16}$ with water slightly in excess of saturation was calibrated for measuring the gamma field in a nuclear reactor. Cross links were induced in polystyrene at a rate of 1 link per 3280 ev of gamma radiation absorbed from a $^{60}Co$ source or per 1420 ev received from mixed radiation from the ORNL Graphite Reactor. Fast neutrons produced considerably larger yields of $H_2$, $CH_4$, and $C_2H_6$ from polystyrene than did gamma rays; the yield of free radicals that were stable at room temperature was independent of the type of radiation absorbed. Liquid-phase pyrolyses of chromatographically pure biphenyl were performed at 422, 438, and 446°C for times up to 50 hr with the biphenyl decomposition limited to less than 1.5%. The first-order decomposition process is described by the specific rate constant, $1.2 \times 10^{-12}$ exp $(-62{,}000/RT)$ $hr^{-1}$. The initial products consisted essentially entirely of hydrogen, benzene, terphenyls, and quaterphenyls in amounts which were consistent with simple stoichiometry. The effects of increased surface area, of changes in the type of surface, of added oxygen and water, and of added deuterium were determined, and some information about the mechanism of the pyrolysis reaction was obtained. (auth)

**22114** (PAN-464/XVII) BADANIE ZMIAN ZACHODZACYCH W TROJCHLOROETYLENIE POD WPLYWEM PROMIENIOWANI JONIZUJACEGO. (The Investigation of Changes of Trichloroethylene Involved by γ Irradiation). Andzej Robalewski and Waclaw Zielinski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 11p.

The influence of γ radiation on trichloroethylene irradiated at various conditions was investigated. Molecular weights and percentage of chlorine in the products formed under irradiation were determined. Infrared spectra of the products are given. (auth)

**22115** (PAN-489/XVII) MODYFIKACJA POWIERZCHNIOWYCH WLASNOSCI POLIETYLENU METODA SZCZEPIEN RADIACYJNYCH. (The Modification of Surface Properties of Polyethylene by Graft-Copolymerization Under γ Irradiation). Andrezej Robalewski and Waclaw Zielinski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 4p.

The influence of different monomers on the grafted polyethylene surface properties was investigated. The methods of coloring and gluing of polyethylene grafted with vinyl acetate was discussed. (auth)

**22116** (PAN-490/XVII) MODYFIKACJA TERYLENU METODA RADIACYJNEGO SZCZEPIENIA. (Improving of Surface Properties of Terylene by Gamma-Radiation-Induced Graft-Copolymerization). Waclaw Zielinski and Teresa Achmatowicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 5p.

Radioinduced grafting of different monomers (in particular 4-vinylpyridine) on terylene was investigated in an attempt to modify dyeing by acidic dyestuffs. (auth)

**22117** (RRL-133) QUARTERLY REPORT [ON RADIATION RESEARCH], JANUARY 1, 1964–MARCH 31, 1964. (Mellon Inst. Radiation Research Labs., Pittsburgh). Apr. 13, 1964. Contract AT(30-1)-2310. 11p. (NYO-2310-1)

Research activities of the Mellon Institute Radiation Research Laboratories are summarized. Abstracts are included for five papers issued in the field of radiation chemistry and summaries are presented on eight programs under investigation. Special interest is shown for the radiolysis of cyclohexene, alkanes, and aqueous methanol-sodium nitrate solutions; radiation effects on energy transfer processes of liquid argon systems; neutron reactions (n,p) with chlorine-35 in carbon tetrachloride for the production of sulfur-35; and the ionization potentials of multiply charged argon, neon, krypton, and xenon. (N.W.R.)

**22118** (TID-20541) EFFECT OF NUCLEAR IRRADIATION ON OXIDATION OF IRON AND COPPER. Jean Morel and W. W. Bradley (Massachusetts Inst. of Tech., Cambridge and Massachusetts Inst. of Tech., Cambridge. Corrosion Lab.). Mar. 27, 1964. Contract [AT(30-1)-2098]. 31p.

The effects of fast neutrons on the oxidation of iron were studied manometrically over both the logarithmic and parabolic oxidation regions with in-pile and out-of-pile experiments. A self-heating capsule was designed for conducting the in-pile oxidation experiments. The in-pile results indicate a small oxidation increase in the logarithmic region up to 220°C, a larger increase in the parabolic region up to 275°C, and a negligible effect above 275°C owing presumably to annealing out of lattice defects in the oxide film. Copper specimens were irradiated for two different periods ($10^{19}$ nvt in 15 days and $3 \times 10^{18}$ nvt in 5 days), and hardness and oxidation measurements were made on the cooled-off specimens. The irradiation temperature was found to be 270°C, at which some of the radioinduced imperfections were undoubtedly annealed out. The hardness at both the $10^{19}$ and $3 \times 10^{18}$ nvt doses was 41, and on heating to 500°C, it decreased to the nonirradiated value of 32. The differences in the oxide thicknesses were insignificant compared to the experimental error. (D.L.C.)

**22119** (UCRL-11215(p.11-12)) THE RADIATION-INDUCED REACTION OF THYMINE WITH ETHANOL IN DEAERATED AQUEOUS SOLUTIONS. Joan Friedman (California. Univ., Berkeley. Lawrence Radiation Lab.).

Thymine was exposed to γ radiation in the presence of benzophenone in a degassed mixed solvent of water and ethanol. Approximately 70% of the thymine initially present yielded two products, neither of which was the starting material, and whose formation was dependent on the presence of ethanol, but not dependent on the presence of benzophenone. These products were characterized by their ultraviolet absorption spectra and by use of $^{14}C$-ethanol

and unlabeled thymine in the synthesis. No assignment of structure has been made. (C.H.)

**22120** (CEA-tr-R-1727) QUELQUES NOUVEAUX COMPOSES RADIOTHERAPEUTIQUES CONTENANT L'ISOTOPE 103 DU PALLADIUM. (Some New Radiotherapeutical Compounds Containing the Isotope Palladium-103). N. G. Serebryakov. Translated into French from Metody Polucheniya Radioaktivn. Preparatov, Sb. Statei, 138-46 (1962). 16p.

A method is described for preparing a radioactive suspension (palladium black) and dextrinous and pectic suspensions of $^{103}Pd$ for use in radiotherapy. The physicochemical properties of the preparations are tabulated. Analysis of the radiosuspensions was also studied. (D.C.W.)

**22121** (JPRS-24289(Del.)) POLYMER CHEMISTRY IN COMMUNIST CHINA. Translated from Chung-kuo K'o-hsueh Yuan Kao-fen-tzu Hsueh-shu Hui-i Hui-k'an, 1961, 296-326(Pub. 1963). 99p. (OTS-64-31121(Del.)).

Six papers translated from the Chinese-language publication Chung-kuo K'o-hsueh-yuan Kao-fen-tzu hsueh-shu Hui-i Hui-k'an: 1961 (Papers of the Chinese Academy of Sciences Symposium on Polymer Chemistry) are presented. Separate abstracts were prepared for each paper. (M.C.G.)

*For abstracts of individual papers see: 22122, 22123, 22124, 22125, 22126, and 22127.*

**22122** (JPRS-24289(Del.)(p.41-3)) THE RADIATION EFFECT ON POLY-ALLYL NITRILES. Nien-yun Lin and Yao-ching Chiang. Translated from Chung-kuo K'o-hsueh Yuan Kao-fen-tzu Hsueh-shu Hui-i Hui-k'an, 1961, 296 (Pub. 1963).

Polyallyl nitriles were irradiated in a reactor at doses from $10^6$ to $10^9$ r. The color was observed, solubility and infrared spectra analyzed, and specific electric resistance measured. The white color began to turn yellow at $5 \times 10^7$ and the color gradually deepened. At $10^7$ r the solubility of the polymer decreased. From analysis of the infrared spectra it was found that the absorption of the atoms declined with increasing radiation dose above $5 \times 10^7$ r. Below $10^7$ r, the specific electric resistance of the polymer decreased with increasing dosage, reaching a minimum between $1 \times 10^7$ and $5 \times 10^7$ r. As the dose was further increased the specific electric resistance increased. (M.C.G.)

**22123** (JPRS-24289(Del.)(p.44-56)) RESEARCH ON THE RADIATION EFFECT OF ALKANE POLYMERS. I. PRELIMINARY DISCUSSION OF THE RADIATION EFFECT ON POLYETHYLENE BY GAMMA RADIATION. Ko-ching Liu, Kuei-hsien Hu, Shu-chen Hsu, Yu-chinng Hsi, and Chih-ying Pu. Translated from Chung-kuo K'o-hsueh Yuan Kao-fen-tzu Hsueh-shu Hui-i Hui-k'an, 1961, 297-303 (Pub. 1963).

Radiation effects on solubility, moistening-expansion degree, unsaturated radicals, and some physical characteristics of polyethylene were studied. Gamma rays from $^{60}Co$ were used to irradiate the polymer. The temperature of gelatinization under vacuum radiation was lower than the temperature of gelatinization determined at high pressure. The effects of air, nitrogen, and hydrogen atmospheres during irradiation were determined. Results are shown on graphs. (M.C.G.)

**22124** (JPRS-24289(Del.)(p.57-63)) RESEARCH ON THE RADIATION EFFECT OF ALKANE POLYMERS. II. PRELIMINARY DISCUSSION ON THE RADIATIVE OXIDATION OF POLYETHYLENE. Shu-chen Hsu, Kuei-hsien Hu, and Ko-ching Liu. Translated from Chung-kuo K'o-hsueh Yuan Kao-fen-tzu Hsueh-shu Hui-i Hui-k'an, 1961, 304-7(Pub. 1963).

Radiation effects on polyethylene were studied in a vacuum, in sufficient air, and in a limited quantity of air. Gamma rays from $^{60}Co$ were used for irradiation. The ratio between bondings and oxidation disintegration structure was not a constant and a maximum value did not exist. The presence of oxygen caused an increase in the temperature of gelatinization and not only influenced the formation of colloid, but also caused the destruction of the colloid. Under conditions of both sufficient and limited air, the carbonyl concentration increased, but the increase was more rapid and greater with sufficient air. (M.C.G.)

**22125** (JPRS-24289(Del.)(p.64-74)) THE RADIATION EFFECT OF POLYETHYLENE. I. X-RAY STRUCTURE ANALYSIS OF POLYETHYLENE AND POLY-ALLYL AMINE AFTER EXPOSURE TO GAMMA RADIATION. I Ho and Tsu-chin Liu. Translated from Chung-kuo K'o-hsueh Yuan Kao-fen-tzu Hsueh-shu Hui-i Hui-k'an, 1961, 308-13(Pub. 1963).

The structure and characteristics of polyallyl amine and polyethylene samples changed after exposure to gamma rays from $^{60}Co$ at room temperature. Measurements were made of percentage of crystallization and characteristics of the crystal phase determined. Below $2 \times 10^9$ r the crystallization percentage did not change. Then it slowly decreased with increasing radiation dose. The x-ray melting point of the sample decreased with increasing dosage. (M.C.G.)

**22126** (JPRS-24289(Del.)(p.75-88)) THE RADIATION EFFECT ON POLYETHYLENE. II. RESEARCH ON THE THERMOMECHANICAL CHARACTERISTICS OF POLYETHYLENE UNDER COBALT-60 GAMMA RADIATION. Ko-chiang Wang, Tsu-tung Kuei, and Shih-yu Chang. Translated from Chung-kuo K'o-hsueh Yuan Kao-fen-tzu Hsueh-shu Hui-i Hui-k'an, 1961, 314-20(Pub. 1963).

A modified version of the Hoppler Viscosity Meter was adapted to measure the thermophysical characteristics of polyethylene before and after irradiation with $^{60}Co$ gamma rays and to examine changes in relationships caused by the transformation of molecular structure under uniform temperature increase and intermittent constant load. Irradiation caused an increase in the thermal stability of polyethylene. Above the melting point it had good elastic properties. The bonding density was proportional to radiation dose, but in the dose range considered (130 and 350 r/sec and $3 \times 10^7$ to $2 \times 10^9$ r), the influence of dose rate on thermophysical characteristics and bonding degree was not large. The melting point and percentage of crystallization changed very little after irradiation. (M.C.G.)

**22127** (JPRS-24289(Del.)(p.89-99)) THE RADIATION EFFECT OF POLYETHYLENE. III. MEASUREMENT OF SOLUBILITY OF POLYETHYLENE AND POLY-ALLYL AMINE AFTER EXPOSURE TO GAMMA RADIATION. Tsu-tung Kuei and Ko-chiang Wang. Translated from Chung-kuo K'o-hsueh Yuan Kao-fen-tzu Hsueh-shu Hui-i Hui-k'an, 1961, 321-6(Pub. 1963).

The Charlesby method was used to measure the solubility of polyethylene and polyallyl amine samples in xylene at 110°C following exposure to gamma radiation from $^{60}Co$. The relationships between dose and solubility derived by Charlesby and T'ang Ao-ch'ing were used to plot curves of colloid quantity vs dose. The ratio between degrees of disintegration and bonding of the polymer varied with increasing dose. (M.C.G.)

**22128** (NP-tr-1138) SELECTIVE SEPARATION OF RADIOACTIVE IODINE. W. Hild and K. H. Lieser. Translated by L. C. Hickman (U.K.A.E.A., Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Naturwissenschaften, 51: 12(1964). 4p.

A procedure was developed for the separation of radioactive iodine using silver chloride containing silica gel as a support substance as the ion exchanger. Preparation of the ion exchange material is described. (P.C.H.)

**22129** VAPOR-PHASE RADIOLYSIS OF CYCLOHEXANE AND MIXTURES OF BENZENE AND CYCLOHEXANE. J. Blachford and P. J. Dyne (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 42: 1165-73(May 1964).

The vapor-phase radiolysis of cyclohexane and benzene–cyclohexane mixtures was studied with isotopic tracer techniques using $C_6D_{12}$ and $C_6D_6$. Benzene does not quench the molecular detachment of hydrogen, $C_6D_{12} \rightsquigarrow D_2 + C_6D_{10}$, but interacts with the second-order processes giving HD in $C_6D_{12}-C_6H_{12}$ mixtures. This interaction is not H-atom scavenging and an ionic mechanism is preferred. The radiolysis of all these systems is very different from their liquid-phase radiolysis. (auth)

**22130** GRAFT COPOLYMERIZATION OF HOMOGENEOUS POLYMETHYLMETHACRYLATE-STYRENE SYSTEM BY PRE-IRRADIATION TECHNIQUE. Kenji Tomioka and Yasuo Shinohara (Toyo Rayon Co., Ltd., Japan). Chem. High Polymers (Tokyo), 21: 83-9(Jan. 1964). (In Japanese)

The mechanism of the graft copolymerization by preirradiation techniques in the homogeneous system was studied. Polymethylmethacrylate (PMMA) powder irradiated with $\gamma$ rays from $^{60}Co$ in air was dissolved in deaerated styrene-benzene solution. The rate of polymerization of styrene in this system was measured dilatometrically. The rate was proportional to the monomer concentration and the square root of PMMA peroxide concentration. The amount of peroxide formed by PMMA by irradiation in the air was measured by iodometry. From these results it was concluded that the mechanism of the polymerization of styrene in this system is the same as that initiated by conventional peroxide initiators. The efficiency of grafting (ratio of grafting polystyrene to the total polystyrene) measured by fractional precipitation was approximately 50%. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**22131** THE REDUCTION OF POTASSIUM FERRICYANIDE BY RADIATION IN AN AQUEOUS $H_2SO_4$ SOLUTION. A. V. Egunov and P. I. Dolin (Inst. of Electrochemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 154: 1153-6(Feb. 11, 1964). (In Russian)

The effect of OH radicals formed in radiolysis can be eliminated by saturating a solution with hydrogen gas at high pressure according to the following reaction: $H_2 + OH \rightarrow H + H_2O$ (1). Then, only the H atoms formed in the hydrolysis of water will be prominent in the reduction of ferricyanide to ferrocyanide by the following reaction: $Fe(CN)_6^{3-} + H \rightarrow Fe(CN)_6^{4-} + H^+$ (2). This system is not complicated by the presence of a large number of competing acceptors. Solutions of $K_3[Fe(CN)_6]$ were irradiated with a $^{137}Cs$ source at a dose rate of $1.93 \times 10^{15}$ ev/ml-sec in 0.8N $H_2SO_4$ at a hydrogen pressure of 40 or 107 atm. The disappearance of ferricyanide was followed spectrophotometrically. With an initial concentration of $16.7 \times 10^{-4}$ M ferricyanide, the reduction of ferricyanide was a linear function of the dose up to 30% conversion of the ferricyanide to ferrocyanide. Since the reduction was dependent on dose, it could be concluded that atomic hydrogen was removed by the following reaction: $H + H \rightarrow H_2$ (3). A plot of the G yield for the reduction versus the initial concentration of $Fe(CN)_6^{3-}$ showed that the ratio of the reaction rate constants $(k_2/k_3)^{0.5} = 0.5$. If it is assumed that $k_3 = 6 \times 10^9$ l/mol-sec, then $k_2 = 3.9 \times 10^4$ l/mole-sec. (TTT)

**22132** THE RADIATION SYNTHESIS OF THE XENON FLUORIDES. G. K. Lavrovskaya, V. E. Skurat, and V. L. Tal'roze (Inst. of Chemical Physics, Academy of Science, USSR). Dokl. Akad. Nauk SSSR, 154: 1160-2(Feb. 11, 1964). (In Russian)

The synthesis of $XeF_2$ and $XeF_4$ was carried out in a stainless steel reactor by irradiating a mixture of xenon and fluorine with 1.6-Mev electrons on cooling the reactor to liquid air temperatures. A total of 30 to 50% of the xenon reacted to form $XeF_2$ and $XeF_4$, which were identified by their infrared spectra. Significant adsorption was observed at wavelengths of 565 and 550 $cm^{-1}$ (corresponding to absorption by $XeF_2$), and less absorption was observed at 584 $cm^{-1}$ (corresponding to absorption by $XeF_4$). A control experiment where fluorine was placed in the reactor without xenon showed no infrared absorption at 565, 550, and 584 $cm^{-1}$. Thus, these results show that $XeF_2$ and $XeF_4$ were obtained by radiation synthesis. If the G yield of hydrogen from the irradiation of methane was assumed to be 5.6 molecules per 100 ev of absorbed dose, the radiation yield for the disappearance of xenon was found to be 0.4 to 0.7 molecules per 100 ev of absorbed dose. This value was valid only for large doses. (TTT)

**22133** THE RADIOLYSIS OF AQUEOUS IRON SULFATE SOLUTIONS BY MEANS OF DECIMICROSECOND ELECTRON IMPULSES. A. K. Pikaev and P. Ya. Glazunov (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 154: 1167-70(Feb. 11, 1964). (In Russian)

A $3 \times 10^{-3}$M solution of Mohr's salt in 0.4M $H_2SO_4$, saturated with air or oxygen, was irradiated at a dose rate of $5 \times 10^{23}$ ev/ml-sec with 1.0-Mev electron pulses from a linear accelerator. The pulse duration was $6 \times 10^{-7}$ seconds with a maximum current of 0.8 amps per pulse. The G yields for the production of $Fe^{3+}$ and for the disappearance of $O_2$ were determined by analyzing the irradiated solutions. The data can be satisfactorily explained by the usual radical reactions in this system. It was found that $\Delta G(Fe^{3+}) = 4\Delta G(-O_2)$, where $\Delta G(Fe^{3+})$ is the difference between the standard $G(Fe^{3+})$ value of 15.5 ions/100 ev and the $G(Fe^{3+})$ value for a high dose rate, and $\Delta G(-O_2)$ is the difference between the consumption of $O_2$ at a low dose rate (3.65 molecules/100 ev) and the $O_2$ consumption at a high dose rate. At a dose rate of $\sim 5 \times 10^{23}$ ev/ml-sec, it was found that $\Delta G(Fe^{3+}) = 4.5 \pm 0.4$ ions/100 ev, and $\Delta G(-O_2) = 1.15 \pm 0.15$ molecules/100 ev. The ratio of the reaction rate constants $K_3K_4/K_7$ was calculated for the following reactions: $Fe^{2+} + OH \rightarrow Fe^{3+} + OH^-$ (3); $H + O_2 \rightarrow HO_2$ (4); and $H + OH \rightarrow H_2O$ (7). The value of $K_3K_4/K_7$ is $3.2 \times 10^7$ l/mol-sec up to a dose rate of $1 \times 10^{23}$ ev/ml-sec, and increases with higher dose rates. The value of $K_3/K_7 = 3 \times 10^{-3}$ and $K_4/K_7 = 3 \times 10^{-2}$. (TTT)

**22134** SOME REMARKS ON THE THERMOLUMINESCENCE OF IRRADIATED MOLECULAR SOLIDS. A. Deroulede, F. Kieffer, and M. Magat (Faculte des Sciences, Orsay, France). Israel J. Chem., 1: 509-15(Dec. 1963). (In French)

Thermoluminescence studies were made on irradiated cyclohexane. The results showed that the intensity of the

thermoluminescence peaks at 95 and 114°K did not depend on preliminary thermal treatment. In contrast, the peak at 149°K was very weak, and the one at 186°K intense in the annealed specimens, the ratio of the intensities being inverse in the wet samples. The addition of benzene ($10^{-3}$ M) augments the height of the peak situated at 90°K from 5.5 to 35.5 (in arbitrary units), whereas that of the 150°K peak passes from 1.9 to 112 and that of the 186°K peak from 0.9 to 52. Remarks are given concerning the luminosity centers. (P.C.H.)

**22135** PHOTOLYTIC AND REDUCTION COLORING OF $CaWO_4$:Nd. D. C. Cronemeyer and M. W. Beaubien (Bendix Corp., Southfield, Mich.). J. Appl. Phys., 35: 1779-85(June 1964).

Intense flash-tube irradiation produces a brownish color in $CaWO_4$:Nd, principally by absorption of wavelengths shorter than 300 mμ. Initially, the photolytic optical absorption has a peak near 3.0 ev for E||c, and at 3.0 ev for E⊥c. At 300°K, there is a fast partial decay of the optical absorption within a few hours followed by a slow subsequent decay which stabilizes within a few days. On approach to equilibrium, the initial 3.0-ev E||c peak decomposes to two peaks at 2.5 and 3.0 ev. The absorption for E⊥c diminishes with time, but the peak remains near 3.0 ev. The absorption coefficient for E||c in this photolytic case is always about twice that for E⊥c. The photolytic coloring is removed by heating at 300°C for a few hours. It is unaffected by compensation of Nd with Na. Reduction of lightly doped $CaWO_4$:Nd induces an optical absorption that peaks at 2.5 ev for both E||c and E⊥c. For heavily doped $CaWO_4$:Nd:Na, absorption peaks at 2.2 ev for E⊥c and 2.2 and 2.9 ev for E||c are produced. Thus, reduction and photolytic coloring have fairly similar spectra. The removal of reduction coloring requires 800°C heating in an oxidizing atmosphere, however. Pure $CaWO_4$ does not color in the bulk by either reduction or photolytic processes. The observations seem to point to an oxygen vacancy model with possible trapping of two electrons (perhaps an oxygen vacancy in conjunction with two $W^{5+}$ ions). (auth)

**22136** RELATION BETWEEN E′ CENTERS AND HYDROXYL BONDS IN SILICA. R. A. Weeks and E. Lell (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 35: 1932-8(June 1964).

The relation between the concentration of intrinsic paramagnetic states (the E′ centers) of silica (silica glass) produced by irradiation and the concentration of $OH^-$ ions in the silica was investigated by introducing $OH^-$ ions into silica, initially free of these ions, in a controlled manner. Optical absorption and electron spin resonance measurements were used to establish the relation. The results of the investigation showed that in synthetic silicas the concentration of E′ centers varied linearly with the concentration of hydroxyl units, the sum of the concentrations of hydroxyl units and E′ centers being constant. A vacancy model for the silica structure is proposed. In terms of this model the estimated saturation concentration of E′ centers is of the same order as the concentration of "vacancies," $\sim 10^{20}$ $cm^{-3}$. The saturation concentration of hydroxyl units is also $\sim 10^{20}$ $cm^{-3}$. Silica made by fusing natural quartz crystals differs from the synthetic silica with respect to the optical bands and the electron spin resonance spectra produced by irradiation. The effects of introducing hydroxyl units into natural quartz silica initially free of hydroxyl units is also different. These differences between natural quartz silica and synthetic silica are related to the models that were suggested for the E′ centers. The models that are suggested are in agreement with the results of other experiments. (auth)

**22137** DIFFERING RESULTS OBTAINED IN THE DOPING OF SEMICONDUCTORS BY ENERGETIC IONS. J. O. McCaldin and A. E. Widmer (North American Aviation Science Center, Canoga Park, Calif.). J. Appl. Phys., 35: 1985-6(June 1964).

Previous results concerning the doping of germanium and silicon crystals by ion bombardment are discussed. The results conflict in that one indicates a doping effect due to the chemical nature of the bombarding ion and the other indicates a doping effect due to radiation damage. It is proposed that these contradictory results are due to the target temperature during the bombardment and the influence of this temperature on the removal of damage centers. (C.E.S.)

**22138** ENERGY TRANSFER FROM CARBON DIOXIDE IN THE RADIATION INDUCED SYNTHESIS OF WATER. P. S. Rudolph and S. C. Lind (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 40: 2601-7(May 1, 1964).

Previous attempts to explain the sensitizing effect of $CO_2$, on the basis of charge transfer, in the radioinduced synthesis of water from its elements were not in agreement with the experimental data. Hence, the reaction was reinvestigated and compared to the nonsensitized synthesis of water. A series of reactions to explain the role of $CO_2$ as a sensitizing agent is postulated herewith. The same scheme (omitting the reactions involving $CO_2$) is applicable to the nonsensitized reaction. Rate equations were derived from the mechanisms. The rate constant for the sensitized reaction in a sphere of 2.43 cm diameter ($K_{2.43}$) is $7.3 \pm 0.2$ $Ci^{-1}$. The constant for the unsensitized reaction is $K_{2.43} = 7.3 \pm 0.3$ $Ci^{-1}$. Carbon dioxide appears to enter into the mechanism even though no $CO_2$ is consumed in the over-all reaction. Evidence is also presented that there is no net reaction of $CO_2$ with water vapor under alpha-particle irradiation. (auth)

**22139** ELECTRON SPIN RESONANCE OF IRRADIATED CRYSTALS OF SODIUM PERFLUOROSUCCINATE. M. T. Rogers (Michigan State Univ., East Lansing, Mich.) and D. H. Whiffen. J. Chem. Phys., 40: 2662-9(May 1, 1964).

The electron spin resonance spectra of the radical $CO_2^-CF_2CFCO_2^-$ trapped in a single x irradiated crystal of sodium perfluorosuccinate hexahydrate were examined at both 9000 Mc/sec and 35,000 Mc/sec. The principal values of the hyperfine coupling tensor for the α fluorine are +421, +165, and +11 Mc/sec; for one of the β fluorine +176, +64, and +52 Mc/sec, and for the other β fluorine +200, +75, and +64 Mc/sec. These are briefly discussed in terms of the electronic structure and the values in chemically related radicals. (auth)

**22140** CHEMISORPTION AND SURFACE DEFECTS IN IRRADIATED MAGNESIUM OXIDE. R. L. Nelson and A. J. Tench (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Phys., 40: 2736-7(May 1, 1964).

Studies on the chemisorption and surface defects in irradiated MgO indicate that a surface center (S) is responsible for at least part of the fast chemisorption of oxygen. Loss of electrons from bulk F centers appears to be connected with the slow chemisorption process. The production of S centers alone on γ irradiation indicates that no oxygen ion vacancies exist in the bulk, but those on the surface are readily populated with electrons. On neutron irradiation S and F centers are produced in roughly comparable numbers although the bulk atoms outnumber the surface atoms by

~40:1. This has implication in calculations of neutron induced surface damage. (P.C.H.)

**22141** DESCRIPTION OF AN APPARATUS PERMITTING IRRADIATION BY ELECTRONS FROM 10 TO 100 kev. Paul Claes, Pierre Huyskens, Jean-Louis Gailliez, and Stefan Rzad (Universite, Louvain, Belg.). J. Chim. Phys., 61: 271-7(Mar. 1964). (In French)

The chemical effects of 10- to 100-kev electrons on gases and liquids are studied with the facility. The dosimetric techniques used are described, as well as the apparatus itself. (D.C.W.)

**22142** EMISSION OF LIGHT BY VITREOUS QUARTZ PREVIOUSLY IRRADIATED BY GAMMA RAYS. Marguerite Lautout-Magat and Fernand Kieffer (Faculte des Sciences, Orsay, France). J. Chim. Phys., 61: 409-11(Mar. 1964). (In French)

Under gamma irradiation, absorption bands appear in the quartz at 2200, 3000, and 5000 Å. Irradiation in the frequency domain of the two lower bands quenches the third band as well as the two lower bands. No further photostimulated emission is possible. Rapid quenching seems to offer a flash lamp with narrow emission bands. Also, the emitted light is of higher frequency than the absorbed light. Emission by irradiated Herasil has been obtained using a xenon flash. (D.C.W.)

**22143** ENRICHMENT OF COBALT-60 ACTIVITY BY SZILARD-CHALMERS PROCESS. Moon-lung Yin and Tung-ching Lee (Tunghai Univ., China). J. Chinese Chem. Soc. (Taiwan), 10: 210-17(Dec. 30, 1963).

In order to investigate the feasibility of producing enriched $^{60}Co$ activity by Szilard-Chalmers process, the complexes tris-[1-nitroso-2-naphthol] Co(III) (A), tris-ethylenediamine Co(III) chloride (B), and potassium cobalticyanide (C) were prepared and used for investigation. The percentage activity yield and enrichment factor for each complex were estimated. The observed highest values of enrichment factor for the complexes (A), (B), and (C) were 287, 18.8, and larger than 3300, respectively. (auth)

**22144** RADIATION GRAFTING TO POLYMER CHAIN FOLDS. D. C. Bassett and R. Salovey (Bell Telephone Labs., Murray Hill, N. J.). J. Polymer Sci., Pt. B, 2: 503-5(May 1964).

Attempts were made to introduce $CCl_4$ into isotactic poly(4-methyl pentene-1) (P4MP) that would be attached mainly to the folds on irradiation. The results did not indicate that in P4MP radiation grafting occurs preferentially at fold surfaces. However, they did show that a high efficiency of attachment to folds may be achieved by irradiation. (P.C.H.)

**22145** IRRADIATION CROSSLINKING OF POLYETHYLENE: RELATIVE EFFICIENCY IN CRYSTALLINE AND AMORPHOUS STATES. R. Kitamaru, L. Mandelkern, and J. Fatou (Florida State Univ., Tallahassee). J. Polymer Sci., Pt. B, 2: 511-17(May 1964).

Attempts were made to determine the relative efficiency of crosslinking between the crystalline and amorphous portions of polyethylene by using molecular weight fractions that encompass a wide range in molecular weights and by crystallizing the samples under controlled conditions. Irradiations were conducted at a temperature where the same molecular weight fractions were maintained either in the completely amorphous state or in a state characterized by a very high level of crystallinity. The results were found to be in accord with the general theoretical expectations for the random crosslinking of random chains. The data also showed that at the same dosage a significantly greater number of intermolecular crosslinks were introduced into the highly crystalline polymer as compared with the completely amorphous one. The relative efficiency of the crosslinking, as is indicated by the critical conditions for gelation, is 1.9 times greater in the crystalline state than in the amorphous state. (P.C.H.)

**22146** ELECTRON SPIN RESONANCE SPECTRA OF IRRADIATED MONOFLUORACETAMIDE. R. J. Cook, J. R. Rowlands, and D. H. Whiffen (National Physical Lab., Teddington, Middx., Eng.). Mol. Phys., 7: 31-43(1963-64).

The radical trapped in x-irradiated monofluoracetamide is shown to be $CHFCONH_2$ by electron spin resonance studies. The principal values of the hydrogen hyperfine coupling are −96, −63, and −31 Mc and of the fluorine coupling are +530, −11, and −45 Mc. The relative signs of the principal couplings were established, using a spectrometer operating at 35,000 Mc which is briefly described. The differences in spectra between measurements at 9000 and at 35,000 Mc are indicated. Finally the couplings are interpreted and shown to be consistent with Hückel parameters for fluorine with $(\alpha_F - \alpha_C) = 2.4\ \beta_{F-C}$. (auth)

**22147** THE ELECTRON SPIN RESONANCE OF A RADICAL IN IRRADIATED FUROIC ACID. R. J. Cook, J. R. Rowlands, and D. H. Whiffen (National Physical Lab., Teddington, Middx., Eng.). Mol. Phys., 7: 57-64(1963-64).

The action of γ-rays on 2-furoic acid is shown, by means of electron spin resonance spectroscopy, to give, in low yield, a radical formed by the addition of a hydrogen atom at position 5. The hyperfine couplings are shown to be in accord with the expected electronic structure for this radical with a negative spin population at $C_3$. (auth)

**22148** ELECTRON SPIN RESONANCE ON AN X-RAY IRRADIATED SINGLE CRYSTAL OF DISODIUM HYDROGEN ARSENATE, $Na_2HAsO_4 \cdot 7H_2O$. W. C. Lin and C. A. McDowell (Univ. of British Columbia, Vancouver). Mol. Phys., 7: 223-34(1963-64).

X-ray irradiation of disodium hydrogen arsenate $Na_2HAsO_4 \cdot 7H_2O$ was shown to produce a paramagnetic species exhibiting a quartet due to hyperfine interaction at the $^{75}As$ nucleus. The g-tensor and the hyperfine coupling were found to be axially symmetric. A theoretical treatment is given that enables the experimental observations to be used to evaluate the hyperfine interaction tensor, the principal values of which are A = 2031.8 Mc and B = 1581.6 Mc. The paramagnetic species was identified as the $\cdot AsO_3^{2-}$ radical anion with symmetry $C_{3v}$. (auth)

**22149** ELECTRON SPIN RESONANCE INVESTIGATION OF ULTRAVIOLET AND X-IRRADIATED METHIONINE. H. Moenig and R. Koch (Universität, Freiburg i. B.). Nature, 202: 289-90(Apr. 18, 1964).

The effects of uv and x irradiation on the ESR spectra of methionine were investigated. After x irradiation of the methionine a very characteristic pattern of the electron spin resonance spectrum was obtained. Before uv irradiation the radical concentration of the x irradiated methionine was $1.5 \times 10^{17}$ spins/g. For technical reasons, the samples could only be measured some hours after irradiation and storage at 17°C. Irradiation of the x-irradiated methionine with uv led to rapid decay of the radical concentration, which reached a minimum after 30 min and then increased again. The increase of the radical concentration is produced by a new radical. The new signal lies

in the region of lower magnetic field strength. Besides the formation of the uv induced signal the formation of sulfuretted hydrogen was detected and the sample turned brown. (P.C.H.)

**22150** ELECTRON SPIN RESONANCE SPECTRUM OF IRRADIATED CELLULOSE II. G. S. Park (Welsh Coll. of Advanced Tech., Cardiff, Wales) and J. C. Ward. Nature, 202: 389(Apr. 25, 1964).

A differential plot of the ESR spectra of cellulose specimens several weeks after receiving a 10-Mrad dose of $\gamma$ radiation is presented. It is suggested that the difference in the ESR patterns is a reflection of the differences in molecular arrangement in cellulose I and cellulose II crystallites. (C.E.S.)

**22151** SOLVENT EXTRACTION OF CARRIER-FREE RADIOACTIVE GOLD FROM HYDROHALOGENIC ACID SOLUTIONS. Hidehiro Goto, Shin Suzuki, Makoto Saito, and Mokuyoshi Kishimoto (Tohoku Univ., Sendai). Nippon Kagaku Zasshi, 85: 75-6([Jan.] 1964). [(In Japanese)]

A study was made on the extraction of carrier-free radioactive gold from hydrofluoric, hydrochloric, hydrobromic, and hydroiodic acid solutions with six organic solvents, ethyl ether, isopropyl ether, ethyl acetate, isoamyl acetate, isoamyl alcohol, and methyl isobutyl ketone. The percentage extraction obtained was compared with those at macroamounts of gold previously reported. The organic solvents used except isopropyl ether were effective to extract gold from hydrohalogenic acid solutions other than hydrofluoric acid solution. Especially, the percentage extraction of gold from 1N hydroiodic acid solution was more than 85% with all organic solvents. There was no difference in the percentage extraction among various extractants, but it was considered from the practical point of view that methyl isobutyl ketone and isoamyl alcohol are the better extractants in the organic solvents used. The extraction of gold at tracer concentration is not much different from that at larger concentrations. Only a small portion of carrier-free radioactive gold was extracted from hydrofluoric acid solution. This may be due to the presence of radiocolloid of carrier-free radioactive gold in this solution. (auth)

**22152** IRRADIATION EFFECTS ON Zr–STEAM REACTIONS. EQUIPMENT USED IN DIDO AND PLUTO EXPERIMENTS. R. C. Asher, A. Hall, C. Howard, and T. B. Kirstein. Nucl. Eng., 9: 171-4(May 1964).

The effects of fast neutrons on the corrosion of zirconium alloys exposed to water or steam-water mixtures at 260 to 340°C were studied. Initial experiments were carried out with Dido and Pluto. (R.E.U.)

**22153** DEFECTS IN IRRADIATED SILICON: ELECTRON PARAMAGNETIC RESONANCE AND ELECTRON-NUCLEAR DOUBLE RESONANCE OF THE Si-E CENTER. G. D. Watkins and J. W. Corbett (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 134: A1359-77(June 1, 1964).

The Si-E center is one of the dominant defects produced by electron irradiation in phosphorus-doped vacuum floating zone silicon. It introduces an acceptor level at $\sim(E_c - 0.4)$ev and gives rise to an electron paramagnetic resonance when this level does not contain an electron. As a result of electron paramagnetic resonance (EPR) and electron-nuclear double resonance (ENDOR) studies, it is concluded that the defect is a lattice vacancy trapped next to a substitutional phosphorus atom, with EPR arising from the neutral charge state. The observed hyperfine interactions with $^{31}P$ and neighboring $^{29}Si$ nuclei, as well as the observed g-tensor anisotropy, are discussed in terms of a simple linear combination of atomic orbitals (LCAO) molecular orbital treatment. In addition to the anisotropy associated with the phosphorus-vacancy direction in the lattice, an additional distortion of the defect occurs which is identified in the LCAO treatment as a manifestation of the Jahn-Teller effect. Thermally activated reorientation from one Jahn-Teller distortion to another causes motional broadening and narrowing effects upon the EPR spectrum in the temperature region 60–150°K. The motion is also studied by stress-induced alignment at lower temperatures and the activation energy for this process is determined to be ~0.06 ev. Alignment of the phosphorus-vacancy direction in the lattice is also achieved by stressing at elevated temperatures. The activation energy for this motion is 0.93 ± 0.05 ev. The magnitude and sense of the alignment in both kinds of stress experiments are consistent with the microscopic model of the defect. The role of the phosphorus-vacancy interaction in the diffusion of phosphorus in unirradiated silicon is discussed. Using the published value for the diffusion activation energy for phosphorus in silicon, the appropriate value for silicon self-diffusion is estimated to be 3.94 ± 0.33 ev and the formation energy for the lattice vacancy in silicon is estimated to be 3.6 ± 0.5 ev. These are quantities for which no direct experimental values are available. Also included are estimates of $|\psi_{3_s}(0)|^2$ and $\langle r_{3_p}^{-3} \rangle$ for the 3p atoms aluminum through chlorine. (auth)

**22154** DELAYED FLUORESCENCE IN PULSE RADIOLYSIS OF ANTHRACENE SOLUTIONS IN BENZENE. Judith M. Nosworthy (Guy's Hospital Medical School, London) and J. P. Keene. Proc. Chem. Soc., 114(Apr. 1964).

Delayed fluorescence from solutions of anthracene in benzene excited by 4-Mev electrons was observed and its time variation was followed. With a 2 $\mu$sec electron pulse of about 7000 rads and no additional light, long-lived light emission from a de-aerated 0.035 M solution of anthracene in benzene was found. The maximum emission occurred at about 4300 Å, which is the wavelength appropriate to normal or delayed fluorescence. (P.C.H.)

**22155** RADIATION DECOMPOSITION OF AQUEOUS SOLUTIONS WITH $\gamma$-RAYS OF $Co^{60}$. Tadamasa Shida (Inst. of Physical and Chemical Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 39: 385-406(Nov. 1963). (In Japanese)

Radiolysis of aqueous solutions of azide and nitrite was studied with $\gamma$ rays of $^{60}Co$. When mercuric salts were added to the solutions, the G value of mercuric reduction attained a high value inexplicable by the radical theory. The assumptions that the excited water molecules as well as radicals are produced in spurs and that they are long-lived and can react with some reactive solutes explained the experimental results. Photolysis of the same system was also studied to obtain results consistent with those of radiolysis. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**22156** INFLUENCE OF RADIOACTIVE IRRADIATION ON THE RATE OF TOPOCHEMICAL EXCHANGE-TYPE REACTIONS. A. P. Buntin and V. N. Neustroeva. Tr. Tomsk. Gos. Univ., 154: 14-22(1962).

The influence of preliminary irradiation of solid acetates of copper, lead, cobalt, barium, and trivalent iron on the rate of their reaction with gaseous $H_2S$ was studied. It was found that both the irradiation dose and the dose rate influence the rate of the chemical process. At a constant

dose rate, an optimum irradiation dose was observed to exist for all the acetates, corresponding to a maximal increase in the rate of the process. An attempt was made to show that the value of the optimum irradiation dose depends on the degree of polarity of the M—O bond in solid acetates, on the medium in which the reaction takes place, on the value of the ionization potential of the metal playing the role of the cation in the given salt, and on the crystal lattice energy. No direct proportionality of the dependence of the reaction rate on the dose rate and irradiation dose under the action of irradiation was found. (Referativnyy Zhurnal, Khimiya, No. 23, Dec. 1963)

**22157** RADIATION MEASUREMENTS—COMPARISON OF RADIOLYSIS OF COBALT-60 GAMMA RAYS AND 3–6 Mev ELECTRONS ON NITRILE SYSTEMS. Gordon H. Miller (Texaco Research Center, Beacon, N. Y.) and Joseph J. Martin. Trans. N. Y. Acad. Sci., 25: 290-1 (Jan. 1963).

Results are reported on attempts to develop a liquid chemical dosimeter useful in the dose range from $10^6$ to $10^8$ rad or above, using acetonitrile; to determine the type and yield of radiolysis products from this material; and to determine whether the high instantaneous dose rate of electrons from a pulsed linear accelerator has a radiolysis effect different from that of $\gamma$ radiation, as measured by changes in dosimeter products. Data indicate that: purified acetonitrile makes a satisfactory dosimeter over the range $1 \times 10^6$ to $6.5 \times 10^8$ rad; the weight per cent yield of CN is an exponential function of the total dose in megarads as given by: $CN = 0.005\ (Dose)^{0.8245}$; the principal gaseous products are $H_2$ (G = 0.58) and $CH_4$ (G = 0.63), with minor yields of $NH_3$, $C_2H_2$, $N_2$, HCN, $C_2H_6$, and $C_4H_{10}$; identified heavier products are $C_2$, $C_3$, and $C_4$ aliphatic nitriles, succinonitrile, malononitrile, and acetonitrile dimer (3-iminobutyronitrile); a complex polymer (G = 8) imine or amine and nitrile groups, the C-H-N proportions approach $(CH_3CN)_x$ and the measured CN yield used in dosimetry is largely contained in the polymer; a new calorimetric method for absolute dose measurement of the electron beam is satisfactory; and the accelerator radiation is not significantly different from the $^{60}Co$ radiation. (BBB)

**22158** THE FORMATION AND RECOMBINATION OF FREE RADICALS ON $\gamma$-IRRADIATION OF POLYPROPYLENE. [PART] I. V. K. Milinchuk (Karpov Inst. of Physics and Chemistry, Moscow). Vysokomolekul. Soedin., 5: No. 1, 71-4 (Jan. 1963). (In Russian)

Crystalline and amorphous polypropylene were treated by means of a $^{60}Co$ $\gamma$-ray source. It was found that at an irradiation temperature of 20°C, more free radicals accumulated in the crystalline than the amorphous sample. The reverse is true at –195°C. The temperature dependence of the free radical concentration of the polypropylene irradiated at –195°C is higher in the amorphous than in the crystalline specimens, which reflects a higher rate of radical combination in the amorphous state. The EPR spectra of the crystalline form depend on the measuring temperature. Graphs are given showing the spectra of the nuclear magnetic resonance of crystalline and amorphous polypropylene at 20°C, the production of free radicals in the polypropylene forms at –195°C and 20°C, and the dependence of the concentration of free radicals in polypropylene upon the temperature during a constant warming time. (OID)

**22159** RADIATION POLYMERIZATION IN THE SOLID PHASE. II. POLYMERIZATION OF VINYL ACETATE. VARIATIONS OF THE TEMPERATURE DEPENDENCE OF THE POLYMERIZATION RATE. I. M. Barkalov, V. I. Goldanskii, N. S. Enikolopyan, S. F. Terekhova, and G. M. Trofimova (Inst. of Chemical Physics, Academy of Sciences, USSR). Vysokomolekul. Soedin., 6: 89-102 (Jan. 1964).

The radiation polymerization of vinyl acetate was investigated in the temperature range from –196 to 0°C in the liquid and solid phases (in vitreous, fine-, and coarse-crystalline form). The activation energy of the polymerization of vinyl acetate was equal to 3.7 kcal/mole in the liquid phase and 0 in the solid phase. The absolute polymerization rate of vitreous vinyl acetate was approximately an order of magnitude greater than that of crystalline vinyl acetate. The molecular weight of the polymer obtained was found to drop with increasing dose. Post-polymerization of vinyl acetate in the solid phase was absent at all investigated temperatures below the melting point (–93°C). Direct calorimetric measurements showed that the entire vinyl acetate polymerization occurs only during the process of irradiation, despite the retention of the shape and intensity of the electron paramagnetic resonance signal arising during irradiation, when the irradiation was stopped. The nature of the temperature dependence of the initial polymerization rate in the solid and liquid phases was the same for methylmethacrylate and formaldehyde as for acrylonitrile and vinyl acetate ($E \approx 0$ in the solid phase and $E > 0$ in the liquid phase). For isobutylene and other monomers polymerizing according to a purely ionic mechanism, $E > 0$ in the solid phase and $E < 0$ in the liquid phase. A small positive activation energy was observed for phenylacetylene in the entire temperature range from –196 to 85°C, both in the liquid and solid phases, with the maximum rate at the melting point. Specific features of the rapid solid-phase polymerization during irradiation were correlated either to effective participation of short-lived excited states in the propagation of the energy chains or to a change in the state of the solid during irradiation. (OTS)

**22160** AN INTRODUCTION TO RADIATION CHEMISTRY. J. W. T. Spinks and R. J. Woods. New York, John Wiley and Sons, Inc., 1964. 485p. $12.75.

Information is included on development of radiation chemistry; sources of radiation; interaction of radiation with matter; radiation dosimetry; ions and excited molecules; free radicals; gases; water and aqueous solutions; aliphatic compounds; aromatic compounds; radioinduced polymerization and the irradiation of polymers; effects of radiation on solids; and industrial uses of radiation. Data, symbols and abbreviations used, and radiation chemistry problems are appended. (P.C.H.)

**22161** THE FORMATION OF FREE RADICALS IN POLYMERS BY RADIATION, THEIR REACTIONS AND REACTIVITIES. M. G. Ormerod (Royal Military Coll. of Science, Shrivenham, Wiltshire, Eng.). p.107-38 of "Advances in Nuclear Science and Technology. Vol. 2." New York, Academic Press, 1964.

The effects of ionizing radiation on polymers are discussed. The detection of free radicals by different methods is considered. Radical formation, reactions, stability, and behavior in specific polymers are discussed. The effects of gases and additives on polymer radicals are discussed. The formation of radicals by means other than ionizing radiation is considered. 145 references. (R.E.U.)

**22162** APPLICATION OF A PULSED SOFT X-RAY SYSTEM TO THE DETERMINATION OF PHOSPHOR RESPONSE CHARACTERISTICS. J. C. McCue (Edgerton,

Germeshausen and Grier, Inc., Boston). 48p. (CONF-174-11)

From 12th Annual Conference Application of X-ray Analysis, Denver, Aug. 1965.

A compact, high intensity pulsed soft x-ray system was used to study the response characteristics of a plastic scintillation phosphor (NE-102). In particular, the decay characteristics of this phosphor plated on one surface with a thin (<1000 Å) layer of aluminum were investigated. Estimates of x-ray scintillation efficiency were obtained, using two separate methods, which were in agreement to within a factor of two. The primary purpose was to establish the validity of transferring calibration data from plated to unplated NE-102 scintillators employed in a photometric recording system. The results of the ensuing investigation indicated the equivalence of the two, but revealed several interesting and unsuspected phenomena. These were an apparent scintillation light reflectance component of zero from the plated aluminum mirror surface; a change in pulse waveform from electron beam input to scintillation output; and a 90 nanosecond delay between electron beam and photomultiplier signals. Uncertainties and other measurement errors caused independent estimates of 0.1% to 0.2% for the external scintillation light efficiency. (P.C.H.)

**22163** CHLOROSULFONYLATION OF POLYETHYLENE. R. V. Dzhashatspanyan, L. M. Yakimenko, A. I. Gershenovich, and V. I. Zetkin. Russian Patent 150,625.

A method for chlorosulfonylating polyethylene with a mixture of chlorine and sulfur dioxide is described. The chlorosulfonylation is carried out at room temperature in a fluidized bed under ionizing radiation. (A.I.D. Press, 2: No. 178, March 1964)

## Separation Processes and Procedures

*Refer also to abstract 22367.*

**22164** (ANL-6815) LABORATORY STUDIES OF IODINE BEHAVIOR IN THE EBR-II MELT REFINING PROCESS. N. R. Chellew, C. C. Honesty, and R. K. Steunenberg (Argonne National Lab., Ill.). Jan. 1964. Contract W-31-109-eng-38. 44p.

Various laboratory studies were conducted in an effort to predict the behavior of fission product iodine in the EBR-II melt refining process. Both highly irradiated EBR-II-type fuel and uranium-fissium alloys that were spiked with iodine were used. When these materials were melt refined in lime-stabilized zirconia crucibles for one hour at 1400°C under an argon atmosphere, over 99% of the iodine was removed from the product ingot by volatilization. The volatilized iodine was collected primarily as CsI. These results confirmed earlier data obtained with unirradiated and low-activity-level fuel alloys, inasmuch as the iodine that was volatilized during melt refining was not in the elemental form. After the fuel was melt refined and the furnace cooled to equilibrium with the ambient temperature, the argon atmosphere in the furnace contained less than 0.02% of the iodine activity in the original charge. Most of this activity was particulate in nature. A trap consisting of high-efficiency filters and an activated charcoal bed effectively removed the iodine activity from the argon atmosphere as it was pumped from the furnace. In the EBR-II Fuel Cycle Facility, a Fiberfrax fume trap on top of the zirconia crucible will be used to collect the condensable materials that are volatilized during melt refining. Results of small-scale experiments indicated that the iodine activity collected by the Fiberfrax fume trap during melt refining will be released to the argon atmosphere of the process cell at a maximum rate of 0.2%/hr when the fume trap is removed from the furnace and placed in storage. (auth)

**22165** (ANL-6818) THE EBR-II SKULL RECLAMATION PROCESS. PART I. GENERAL PROCESS DESCRIPTION AND PERFORMANCE. Leslie Burris, Jr., I. G. Dillon, and R. K. Steunenberg (Argonne National Lab., Ill.). Jan. 1964. Contract W-31-109-eng-38. 28p.

A general description of the EBR-II skull reclamation process and a flowsheet showing the individual process steps are presented. After the enriched uranium-fissium alloy used in the first core loading of EBR-II is processed by melt refining, approximately 10% of the fuel remains in the crucible as a residue of unpoured and oxidized metal. This residue constitutes the "skull." The objectives of the skull reclamation process are: to recover the uranium from the skull, and to remove fission products from the uranium. A large fraction of the fission products removed in the EBR-II fuel cycle are removed in the skull reclamation process. Liquid metals and molten salts are used as the processing media. Separation of fission products from the fuel is effected primarily by selective reduction of compounds of relatively noble fission product elements by zinc and extraction of the reduced fission product elements into zinc for disposal, and by selective precipitations of a uranium–zinc intermetallic compound and uranium metal from liquid metal solutions. Fission product elements are retained in the supernatant solutions and these are discarded to waste. The precipitated uranium is recovered by removing the supernatant liquid metal and retorting to vaporize the residual solvent metals. Because the skull constitutes only a small sidestream of material in the overall fuel cycle, only modest uranium recoveries are required. A uranium recovery of about 95% is adequate. The requirements for fission product removal are also modest, particularly for the noble fission product elements, which are deliberately used in the fuel material as alloying elements. Removals of as low as 50% are sufficient for these alloying fission product elements. For other fission product elements, removals of about 90% are adequate. These recovery and purification requirements were shown to be readily achievable in the skull reclamation process. (auth)

**22166** (CONF-322-11) THE MECHANISM OF EXTRACTION OF HEXAVALENT URANIUM BY TRILAURYLAMINE NITRATE. P. J. Lloyd and E. A. Mason (Massachusetts Inst. of Tech., Cambridge). [1963]. Contract W-7405-eng-26. 32p.

From American Chemical Society Production Technology of Np-237 and Pu-238, Denver, Jan. 1964.

The effects of amine, uranium, and hydrogen ion concentrations on the extraction of $U^{VI}$ from acidic nitrate solutions by tri-n-dodecylamine nitrate in toluene was studied in detail. Over a wide range of these variables, it was found that the data could be correlated quantitatively on a basis of a mechanism of extraction involving equilibria between amine nitrate monomer and dimer species, extraction of uranium by both of these species, and extraction of nitric acid by the amine nitrate: $2R_3NHNO_3 \rightleftharpoons (R_3NHNO_3)_2$, $UO_2(NO_3)_2 + 2R_3NHNO_3 \rightleftharpoons (R_3NHNO_3)_2UO_2(NO_3)_2$, $UO_2(NO_3)_2 + 2(R_3NHNO_3)_2 \rightleftharpoons [(R_3NHNO_3)_2]_2UO_2(NO_3)_2$, and $HNO_3 + R_3NHNO_3 \rightleftharpoons R_3NHNO_3 \cdot HNO_3$. By determination of the nitric acid extracted into the organic phase by the fourth equilibrium, it was possible to calculate the concentration

of amine nitrate available for participation in the other equilibria. From a reported value of K = 125 ± 25 for the first equilibrium, values of $K_1$ = 50 ± 10 and $K_2$ = 200 ± 50 were estimated for the second and third equilibria, respectively. Data are also presented on the variation of nitrate and hydrogen ions in the organic phase with uranium loading, from which it is concluded that no species other than the uranyl dinitrate complex is extracted. The difficulties caused by amine nitrate aggregation during studies on the mechanism of extraction of metals by other amines in other diluents are discussed. (auth)

**22167** (DP-874) DISSOLVING HIGHLY IRRADIATED Pu–Al ALLOY. William C. Perkins (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Feb. 1964. Contract AT(07-2)-1. 12p.

Samples of highly irradiated Pu–Al alloy dissolved at an average rate of 0.5 mg/(min)($cm^2$) in 6M $HNO_3$–0.05M $Hg(NO_3)_2$–0.02M HF solution. In 2.1M NaOH–2.6M $NaNO_3$ the aluminum in the alloy dissolved at an average rate of 14 mg/(min)($cm^2$), and the actinides dissolved completely when the caustic solution was acidified and boiled. (auth)

**22168** (DP-877) RECOVERY OF FISSION PRODUCTS FROM PUREX WASTE. William E. Prout and E. Kenneth Dukes (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Feb. 1964. Contract AT(07-2)-1. 12p.

Laboratory studies were made to determine the feasibility of simultaneously recovering cesium, strontium, and rare earth fission products from Purex wastes by precipitation techniques. In the primary separation, rare earth–sodium sulfates, strontium sulfate (with lead carrier), and cesium molybdophosphate were precipitated. Cesium was separated satisfactorily as a crude fraction from the primary product; however, suitable fractions of strontium and rare earths were not obtained by the procedures that were tested. (auth)

**22169** (IDO-14628) ELECTROLYTIC DISSOLUTION OF NUCLEAR FUELS WITH ALTERNATING CURRENT. F. M. Warzel, K. F. Smith, and J. B. Colson (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Mar. 23, 1964. Contract AT(10-1)-205. 11p.

In preliminary studies of the use of alternating current for electrolytic dissolution of nuclear fuels, uniform current utilization (metal dissolved/amp-hr) was obtained from 2 to 60 cps when the current was fed directly to dual stainless steel electrodes in nitric acid. Above 60 cps the current utilization decreased rapidly. While current utilization in the 2 to 60 cps range was only 65 to 70% of that obtained with direct current, use of alternating current makes possible the use of simplified, lower cost equipment. Dissolution was demonstrated in a "transformer" dissolver in which the energy required was transferred to the fuel without physical connections. (auth)

**22170** (LA-3040) PROCESSING OF PLUTONIUM BY ION EXCHANGE. IV. THE SEPARATION OF PLUTONIUM FROM WEAKLY SORBED IMPURITIES. R. S. Cooper and D. B. James (Los Alamos Scientific Lab., N. Mex.). Jan. 1964. Contract W-7405-eng-36. 28p.

Sorption of plutonium(IV) on anion-exchange resin from 7M nitric acid is an excellent method for its purification. Only a limited number of other elements are sorbed, and most of these only weakly. The fate of such weakly sorbed impurities in this purification process is discussed theoretically for several degrees of approximation to the actual system. A numerical computer calculation closely duplicates the experimental behavior of four selected impurity elements. (auth)

**22171** (MCW-1454) MINIMUM SAMPLE SIZES FOR URANIUM CONCENTRATE SAMPLING. S. D. Nelson, T. J. Kneip, and A. H. Mohl (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Apr. 30, 1964. Contract W-14-108-eng-8. 16p.

A study was made to determine the sample size necessary to reduce the theoretical sampling variance to an insignificant level in sampling well-blended uranium concentrates. This study, following a theory described by Benedetti-Pichler, resulted in sample sizes calculated as functions of the physical and chemical characteristics of the sampled materials and the sampling variance. The sampling variance values chosen were those that would be insignificant with respect to the analytical variance at the 95% confidence level. It was found that the present sampling procedure removes a sample that is larger than that required for well-blended materials. (auth)

**22172** (ORNL-3591(p.59-64)) FLUORIDE SALT PRODUCTION. J. H. Shaffer, F. A. Doss, W. K. R. Finnel, Wiley Jennings, and W. P. Teichert (Oak Ridge National Lab., Tenn.).

Raw materials were purchased and improvements to the fluoride processing facility were made preparatory to the production of the coolant, flush, and fuel mixtures for operation of the MSRE. As a continuing effort for process development, studies of impurity removal rates and of various process control methods were made. The use of stronger reducing agents for the removal of structural-metal cations from fluoride mixtures is being investigated, and both beryllium metal and zirconium metal appear promising for this application. The densification of $^7$LiF by a combination of heating and HF treatment was confirmed in intermediate-scale apparatus, and preparations were made to apply this treatment to the entire supply of $^7$LiF raw materials. The reduction of sulfate to sulfide with beryllium metal may permit the controlled removal of sulfur by HF–$H_2$ sparging without formation of nickel sulfide, provided the $H_2S$–$H_2$ ratio is held below a critical value, known as a function of temperature. (auth)

**22173** (ORNL-3591(p.201-4)) CORROSION STUDIES FOR CHEMICAL REPROCESSING PLANTS. J. C. Griess, J. L. English, L. L. Fairchild, and P. D. Neumann (Oak Ridge National Lab., Tenn.).

Evaluation of materials for use in the Transuranium Processing Facility has continued. Addition of 1M $HNO_3$ reduced the corrosiveness of 3M HCl to Hastelloy C at 43°C by an order of magnitude, but the addition of 0.1M $HNO_3$ was not beneficial. Hastelloy C did not corrode in solutions of mono-2-ethylhexylphenylphosphonic acid in diethylbenzene or Alamine 336 chloride in diethylbenzene. Zircaloy-2 could withstand mixed solutions of nitric and hydrochloric acids at 43°C with low corrosion rates and with no evidence of hydride formation. Zircaloy-2 showed similar behavior in boiling 6M $HNO_3$ solutions containing up to 0.5M HCl, but in boiling 6M HCl solutions containing up to 0.5M $HNO_3$ corrosion at rates up to 20 mils/yr picked up significant amounts of hydrogen. Zircaloy-4 was not better than Zircaloy-2 in most process solutions and was much worse in boiling 6M HCl. Tantalum platings on Hastelloy and stainless steel showed negligible corrosion in hot hydrochloric acid solutions, but an adherent bond between plate and base metal was not maintained in one case. (auth)

**22174** (ORNL-3591(p.213-16)) SOLVENTS FOR FLUORIDE VOLATILITY PROCESS. B. J. Sturm, R. E. Thoma, E. H. Guinn, H. Insley, and T. N. McVay (Oak Ridge National Lab., Tenn.).

The search for high-capacity solvents for use in the Fluoride Volatility Process for recovering uranium from aluminum-based reactor fuels was continued. Partially completed investigations of the ternary systems LiF–KF–$AlF_3$ and KF–$ZrF_4$–$AlF_3$ suggest that the latter system has potential for processing uranium–aluminum alloys. Use of a three-step process makes possible dissolution of approximately 26 mole % $AlF_3$ at temperatures below 600°C. (auth)

**22175** (VDDIT-86) CRITICALITY STUDIES AND SAFETY CONSIDERATIONS, IN PARTICULAR AS APPLICABLE TO PROCESSING PLANTS FOR FISSIONABLE MATERIALS. A Literature Survey. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Feb. 1964. 33p.

References (110) with abstracts (taken mainly from Vol. 16 and 17 of NSA) are included for articles and reports on criticality studies and safety considerations relevant to fissionable material processing. (D.C.W.)

**22176** SOLVENT EXTRACTION STUDIES OF THORIUM(IV) BY DIBUTYLPHOSPHATE (DBP) IN CHLOROFORM, HEXOL (METHYLISOBUTYLCARBINOL) AND HEXANE. David Dyrssen and Djiet Hay Liem (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 18: 224-48 (1964).

The distribution of $^{234}Th$ between aqueous perchloric, nitric, and hydrochloric acid and solutions of dibutylphosphate (= HA) in chloroform, hexol, and hexane was studied. From nitric acid and perchloric acid media Th is extracted into chloroform predominantly as $Th(NO_3)A_3(HA)_2$ and $Th(ClO_4)A_3(HA)_2$ and the extraction can be represented by the equilibrium reactions $Th^{4+}(aq) + X^-(aq) + 5HA(aq) \rightleftharpoons ThXA_3(HA)_2$ (org) + $3H^+$ (aq) where $X^- = NO_3^-$ or $ClO_4^-$; the value of log K was found to be 19.6 in both cases. From hydrochloric acid medium the $Th^{4+}$ is extracted in chloroform as $ThA_4(HA)_2$ and the value of log K for the reaction $Th^{4+}$ (aq) + 6HA(aq) $\rightleftharpoons$ $ThA_4$ $(HA)_2$ (org) + $4H^+$(aq) was found to be log K = 22.5. With hexol and aqueous nitric acid solution $Th^{4+}$ is extracted mainly as $Th(NO_3)_4$ for [HA] < $10^{-5}$ M, $Th(NO_3)_2A_2$ for $10^{-4.6}$ M < [HA] < $10^{-3.5}$ M, and $Th(NO_3)A_3$ (HA) for [HA] > $10^{-3.4}$ M. The extraction can thus be represented by the equilibrium reactions: $Th^{4+}(aq) + 4NO_3^-(aq) \rightleftharpoons Th(NO_3)_4$ (org); log K = −2.0, and $Th^{4+}(aq) + 2NO_3^-(aq) + 2HA(aq) \rightleftharpoons Th(NO_3)_2A_2$ (org) + $2H^+(aq)$; log K = +6.6; and $Th^{4+}(aq) + NO_3^-(aq) + 4HA(aq) \rightleftharpoons Th(NO_3)A_3(HA)$(org) + $3H^+(aq)$; log K = +13.4. With hexane and aqueous nitric acid or hydrochloric acid $Th^{4+}$ is probably extracted as $ThXA_3(HA)_2$, where $X = NO_3^-$ or $Cl^-$, with the following approximate log K values: 14.4 ($NO_3^-$) and 15.5 ($Cl^-$), for the equilibrium reaction: $Th^{4+}(aq) + X^-(aq) + 5HA$ (aq) $\rightleftharpoons$ $ThXA_3(HA)_2$ (org) + $3H^+(aq)$. At higher concentrations of thorium, it is extracted into chloroform as $\{ThX_4(HA)_2\}_n$ where $X = NO_3^-$, $ClO_4^-$ or $Cl^-$, and n represents the degree of polymerization. The addition of TBP causes a decrease of the distribution coefficient of the extraction. This antagonistic effect of TBP (= B) is explained by the formation of HAB complex, thus reducing [HA] and $[A^-]$ for a given total concentration of DBP. The solvent interaction of HA and $H_2A_2$ for different organic diluents is discussed. Data are tabulated. (auth)

**22177** LEACHABILITY OF RADIUM-226 FROM URANIUM MILL SOLIDS AND RIVER SEDIMENTS. S. D. Shearer, Jr., and G. F. Lee (Univ. of Wisconsin, Madison). Health Phys., 10: 217-27(Apr. 1964).

Laboratory leaching tests conducted on uranium mill waste solids and river sediments collected from several locations in the Colorado Plateau area of the United States showed that the amount of radium-226 that can be leached is primarily controlled by the liquid-to-solid ratio (volume of leaching liquid per unit weight of solids). The diffusion of radium-226 from the interior to the surface of the particles was found to be insignificant since the amount leached was essentially independent of time of contact after 15 min. Natural and synthetic river waters showed no greater tendency to leach radium-226 than did distilled water. Leaching tests conducted with 0.01 molar solutions of the common inorganic cations found in river waters showed that only barium significantly promoted the leaching of radium-226 from the solids studied. (auth)

**22178** THE MECHANISM OF URANIUM(VI) EXTRACTION FROM NITRIC ACID SOLUTIONS BY TRI-N-OCTYLAMINE. Taichi Sato (Government Chemical Industrial Research Inst., Tokyo). Naturwissenschaften, 51: 35-7(1964).

The partition of U(VI) between nitric acid solutions and solutions of tri-n-octylamine (TDA) in benzene was investigated by varying the concentrations of nitric acid, solvent, and aqueous uranium at different temperatures. The partition coefficient first rose with acidity, then passed through a maximum at about 7M $HNO_3$, and then fill again. The dependence of the partition coefficient on the solvent concentration indicated that two amine molecules are associated with each uranium ion. This was also supported by the dependence of the uranium concentration in the organic phase on the initial aqueous uranium concentration. The following mechanism was postulated: $UO_2(NO_3)_2 + 2R_3NHNO_3 \rightleftharpoons (R_3NH)_2\,UO_2(NO_3)_4$. (M.C.G.)

**22179** SEPARATION OF $^{137}Cs$ FROM FUEL REPROCESSING WASTE WITH FERROCYANIDE EXCHANGER. Noriyuki Mishio (Ebara Mfg. Co., Ltd., Japan), Atushi Kamoshida, Shozo Kadoya, and Takehiko Ishihara. Nippon Genshiryoku Gakkaishi, 6: 2-7(Jan. 1964). (In Japanese)

A special solid ion-exchange material of ferrocyanide-bentonite mixture (Ferrocyanide-Exchanger) made by a freezing-thawing method was developed for removing $^{137}Cs$ from radioactive wastes. The new adsorption material showed its capability of adsorbing Cs exclusively even from 6N nitric acid solution containing various other ions, and success was obtained in separating $^{137}Cs$ from synthetic Purex waste and Zirflex waste with this new material. 80% elution of $^{137}Cs$ from this ferrocyanide-bentonite exchanger was accomplished by use of silver nitrate solutions. (P.C.H.)

**22180** SEPARATION OF THE LANTHANIDES BY THE ION EXCHANGE WITH α-HYDROXY-α-METHYL BUTYRIC ACID. Tomota Nishi and Ichiro Fujiwara (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 6: 15-20(Jan. 1964). (In Japanese)

The use of a new eluting agent, ammonium α-hydroxy-α-methylbutyrate, for the separation of the lanthanides in cation-exchange chromatography was investigated. The new eluant has given better separation than ammonium α-hydroxy isobutyrate. When ytterbium is taken as an arbitrary standard, separation factors are La 858, Ce 286, Pr 177, Nd 129, Pm 87.0, Sm 49.6, Eu 25.1, Gd 18.2, Tb 9.60, Dy 5.50, Ho 2.99, Er 2.30, Tm 1.35, Yb 1.00, Lu 0.415, Y 5.01, and Sc 0.188. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**22181** TRACER STUDIES ON THE EXTRACTION OF METAL IONS. VI. EXTRACTION OF SCHIFF BASE METAL CHELATES OF URANIUM, IRON, COPPER, NICKEL, AND SEPARATION OF URANIUM FROM RARE-

EARTH ELEMENTS. Jan Mikulski and Ignacy Stronski (Inst. of Nuclear Physics, Krakow). Nukleonika, 8: 827-32(1963).

The relation between the hydrogen ion concentration of the water phase and the yield of extraction (% E) of $UO_2^{2+}$, $Fe^{3+}$, $Ni^{2+}$, and $Cu^{2+}$ ions by means of bis-salicylaldehyde-ethylenediamine, in the system water-chloroform, was studied radiometrically. The uranyl ions were separated from the tervalent praseodymium and gadolinium ions. (auth)

**22182** SEPARATION OF PURE $^{90}Y$ FROM A $^{90}Sr-^{90}Y$ MIXTURE BY CO-PRECIPITATION WITH FERRIC HYDROXIDE, USING A PYRIDINE AS A PRECIPITANT. Yoshio Koda (Government Industrial Research Inst., Nagoya, Japan). Radioisotopes (Tokyo), 12: 363-7(Nov. 1963). (In Japanese)

When coprecipitation with ferric hydroxide by ammonia water was utilized for the separation of $^{90}Y$ from a mixture of $^{90}Sr-^{90}Y$, almost all $^{90}Sr$ in the case without carriers and about 4% of $^{90}Sr$ in the case of carriers coprecipitated with ferric hydroxide. Therefore, enough purity of $^{90}Y$ could not be obtained by this method. By coprecipitation with ferric hydroxide using a pyridine base instead of ammonia water, only about $3 \times 10^{-2}$% of $^{90}Sr$ coprecipitated without carriers. When a carrier of $^{90}Sr$ and $K_2SO_4$ was added to the test solution, satisfactorily pure $^{90}Y$ containing only $3 \times 10^{-3}$% of $^{90}Sr$ could be obtained very easily and rapidly. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**22183** THE SYSTEM URANYL NITRATE + WATER + TRIBUTYL PHOSPHATE + CARBON TETRACHLORIDE. J. J. V. Aartsen and A. E. Korvezee (Technical Univ. of Delft, Holland). Trans. Faraday Soc., 60: 510-18(Mar. 1964).

Phase-equilibria data are given for the ternary UN + $H_2O$ + TBP and for the quaternary system UN + $H_2O$ + TBP + $CCl_4$. The existence of a practically undissociated compound UN 2TBP was confirmed. The freezing-point of this compound is $-9.7_5 \pm 0.1$°C and the equilibrium constant $K_c$ of the reaction $(UO_2^{2+})_{aq.} + 2(NO_3^-)_{aq.} + 2(TBP)_{org.} \rightleftharpoons (UN \cdot 2TBP)_{org.}$ is 48 ± 1 (l/mole)$^4$ at 25.0°C. (auth)

**22184** SEPARATION OF SMALL AMOUNTS OF MOLYBDENUM AND TELLURIUM BY SOLVENT EXTRACTION. V. A. Sokolov and V. I. Levin. Zh. Neorgan. Khim., 9: 742-5(Mar. 1964). (In Russian)

Solvent extraction of Mo and Te from hydrochloric acid solutions by tributylphosphate and its mixtures with carbon tetrachloride was studied and optimum separation conditions were determined. A strong dependence of the separation coefficient for Mo and Te on TBP concentrations in the organic phase was established. (R.V.J.)

**22185** METHODS OF RADIOCHEMICAL ANALYSIS OF LONG-LIVED FISSION PRODUCTS IN VARIOUS OBJECTS OF THE EXTERNAL ENVIRONMENT. SOIL. V. K. Vinogradova. p.63-8 of "Radioaktivnye Zagryazneniya Vneshnei Stredy." Moscow, Gosatomizdat, 1962.

Methods of extracting Ru, Cs, Zr-Nb, Ce, Y, and other rare earth elements, as well as Sr from soil are briefly discussed. Detailed schemes of isolation of radioactive Sr from soil and simultaneous extraction of a mixture of isotopes: Sr, Cs, and Ce from the soil and their radiochemical purification are cited. (TCO)

**22186** FLUIDIZED BED RECOVERY OF FLUORINE IN THE MANUFACTURE OF $UF_6$. W. R. Pedigo, C. R. King, L. A. Dean, J. E. Owen, and S. Bernstein (Union Carbide Corp., Paducah, Ky.). New York, American Institute of Chemical Engineers, 1964, Preprint 15c, 22p, $0.50. (CONF-488-4; TID-20110)

From American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964.

A fluidized bed reactor was developed and installed for the recovery of fluorine from process gas streams associated with the manufacture of $UF_6$. The all Monel reactor employs a bed of $UF_4$ and operates at temperatures in the range of 700 to 750°F. Fluorine recovery is based on the reaction between fluorine and $UF_4$ at these temperatures to form $UF_6$ and intermediate uranium fluorides ($U_2F_9$, $U_4F_{17}$). The system has demonstrated a fluorine recovery efficiency in excess of 98%. Pilot plant operations that led to the development and installation of the plant reactor system are discussed. A description of the design features is presented, along with a review of the economic factors leading to the reactor installation. Current operational experience is also discussed. (P.C.H.)

**22187** THE USE OF FLUID BED EQUIPMENT IN ENRICHED URANIUM PROCESSING. H. M. Heidt, R. P. Levey, Jr., and C. E. Hamrin, Jr. (Union Carbide Corp., Oak Ridge, Tenn.). New York, American Institute of Chemical Engineers, 1964, Preprint 21b, 37p, $0.50. (CONF-488-5)

From American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964.

The use of high-productivity tapered-bed reactor, pulsed bed, and the high-temperature fluid bed reactor for processing enriched uranium is discussed. The reactions involved in uranium processing are given. (P.C.H.)

**22188** FLUIDIZED-BED PROCESSING OF PARTICULATE NUCLEAR FUELS. J. M. Blocher, Jr., M. F. Browning, and J. H. Oxley (Battelle Memorial Inst., Columbus, Ohio). New York, American Institute of Chemical Engineers, 1964, Preprint 21c, 39p, $0.50. (CONF-488-6)

From American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964.

Applications that involve the fluidized-bed processing of particulate nuclear fuels are discussed. Special technological problems are also considered. (P.C.H.)

**22189** METHOD FOR PREDICTION OF PERCENTAGE CONVERSION IN TWO-STAGE FLUID-BED HYDROFLUORINATION SYSTEMS. J. H. Pashley (Oak Ridge Gaseous Diffusion Plant, Tenn.). New York, American Institute of Chemical Engineers, 1964, Preprint 21a, $0.50, 35p. (CONF-488-1; K-L-6003)

From American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964.

A method of correlating laboratory data for conversion of uranium dioxide to uranium tetrafluoride and use of the results to predict product conversion are discussed. The correlating method utilizes the two-parameter logarithmic probability function. Reactor calculations are performed by Gaussian summation of results for predetermined residence times based on the residence time function for a well-mixed bed. The calculation method includes provision for adjustment of the argument of the probability function to compensate for variation of the hydrogen fluoride driving force determined for average bed conditions. A fictitious time is estimated for partially converted feed and is also used to adjust the argument of the probability function. Estimated effects of variation of reaction parameters are given that allow evaluation of potential results for variation of plant conditions and for changes in material fed. The computer program is described briefly. (auth)

**22190** DEVELOPMENT AND PRODUCTION EXPERIENCE WITH MECHANICALLY AGITATED FLUID BEDS AS APPLIED TO THE HYDROFLUORINATION OF FINE URANIUM OXIDE POWDERS. D. C. Brater (Oak Ridge Gaseous Diffusion Plant, Tenn.), J. H. Pashley, S. H. Smiley, D. L. Castro, and L. A. Dean. New York, American Institute of Chemical Engineers. 1964, Preprint 15b, 28p, $0.50. (CONF-488-3; K-L-6002)

From American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964.

Development and production experience with stirred fluid beds for the hydrofluorination of fine uranium oxide powders is discussed. Using mechanically agitated fluid beds, capacity was found to be much greater than was possible with screw reactors used previously, and conversions to $UF_4$ are higher. Operational reliability is excellent, and system performance is virtually trouble-free. (P.C.H.)

**22191** REDUCTION AND HYDROFLUORINATION OF URANIUM CONCENTRATES BY FLUID BED TECHNIQUES. A. H. Sutton, J. C. Bishop, K. J. Stahman, and M. H. Cohen (Allied Chemical Corp., Metropolis, Ill.). New York, American Institute of Chemical Engineers, 1964, Preprint 15a, 33p, $0.50, (CONF-488-2)

From American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964.

Five years operating experience in the use of fluid beds for processing impure uranium concentrates to ultra-high purity $UF_6$ are described. Design criteria of fluid beds, process description, equipment description, and process difficulties are given. (P.C.H.)

**22192** A PROCESS AND APPARATUS FOR CONCENTRATING AND SEPARATING A COMPONENT OF A FLUID MIXTURE. Frances Ruskin. British Patent 957,295. May 6, 1964. Apr. 23, 1959.

A method is described for separating the components of an electrically conducting suspension or solution in either the gaseous or liquid state, if the components to be separated have different diamagnetic properties. The fluid to be separated is passed at high pressure and flow rates through annular pipes that are traversed by radial magnetic fields on the order of 10 kOe. The fluid passes through several sections of the pipe; in adjacent sections, the magnetic field reverses polarity. One of the components concentrates at the outer wall, and the other at the inner wall. They may be removed from the fluid at this point. The process described may be used to separate $D_2O$ from sea water; $U_3O_8$ from uranium ores; $D_2$ from $H_2$; petroleum fractions; and other fluids. (T.F.H.)

**22193** METHOD FOR THE EXTRACTION OF URANIUM VALUES FROM SOLUTIONS IN ORGANIC SOLVENTS. David Jones Crouse, Jr. (to U. S. Atomic Energy Commission). German Patent 1,159,919. Dec. 27, 1963. Priority date Apr. 28, 1960.

The method comprises the steps of treating the organic solution with a watery ammonium carbonate solution, of separating the ammonium carbonate solution containing uranium from the organic phase depleted of uranium values, and of obtaining the uranium values from the watery solution. The watery ammonium carbonate solution is charged with uranium values before the treatment of the organic solution in such a way that on contact with the organic solution a precipitation containing uranium is separated from the watery slurry. (Gmelin Inst.)

**22194** METHOD FOR THE SEPARATION OF PLUTONIUM FROM NEUTRON IRRADIATED URANIUM. Dieter Naumann (to Zentralinstitut fur Kernphysik). German Patent 1,162,821. Feb. 13, 1964. Filed July 4, 1961.

A method for the separation of plutonium from neutron-irradiated uranium, neutron-irradiated uranium compositions, e.g., uranium(IV) oxide, or uranium–plutonium compositions, is described. The uranium-containing materials are chlorinated with gaseous substances like carbon tetrachloride or phosgene. The gaseous chlorides of uranium and plutonium obtained, which are free from water, are adsorbed in a column charged with active carbon. By generation with a drag gas, repeated adsorption and desorption processes take place in this column so that a separation of the chlorides is achieved, the plutonium being deposited at the beginning and the uranium being deposited at the end of the column. The column is either operated under isothermal conditions or a temperature gradient is established along the column. (Gmelin Inst.)

**22195** METHOD OF SEPARATING EUROPIUM. G. V. Korpusov, E. N. Patrusheva, and Yu. S. Krylov. Russian Patent 159,811.

A method is given for separating europium from a mixture of rare earths by treating their aqueous solutions with a reducing agent such as zinc powder, which is distinguished by the fact that, in order to increase the separation factor of europium, after reducing the europium the aqueous solutions are subjected to extraction using, for example, tributylphosphate. (OTS)

# ENGINEERING

## General

**22196** WEAR MEASUREMENT WITHOUT INTRODUCING RADIOACTIVE MATERIAL INTO THE SYSTEM. David H. Morley and Warner W. Schultz (to General Electric Co.). U. S. Patent 3,128,381. Apr. 7, 1964. Filed Mar. 31, 1958.

Metallic surfaces are subjected to wear in the presence of a fluid, which acts as a carrier for wear particles produced. A sample of the fluid is removed from the system and irradiated, as is a sample of unused fluid of the same type. The $\gamma$ spectra of the samples are compared to identify the elements constituting the wear particles. A reference radiation level for the individual materials involved is established and compared with the unknown sample to determine the amount of wear taking place. Alternatively, the particles may be filtered from the fluid and analyzed. Problems associated with radioactivity in the vicinity of the machine are thus avoided. (A.G.W.)

## Facilities and Equipment

*Refer also to abstracts 22643 and 23059.*

**22197** (AEEW-R-205) SOME ELECTRICAL PHENOMENA WHICH OCCUR IN MAGNESIA-INSULATED CABLES. A. Goodings (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Oct. 1962. 43p.

Experiments that were carried out to investigate electric phenomena in samples of magnesium oxide insulated cables are described. An hypothesis that may be used to explain the results is proposed. It is based on semiconductor n-p junctions between individual oxide particles and the layers on their surfaces. (auth)

**22198** (DP-881) GAUNTLET SYSTEM FOR MASTER-SLAVE MANIPULATORS. Paul H. Chismar (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Mar. 1964. Contract AT(07-2)-1. 7p.

An improved gauntlet system was developed to reduce radioactive contamination of master-slave manipulators. The gauntlet protects the in-cell portion of the manipulator and prevents escape of contamination through the manipulator port in the cell wall. (auth)

**22199** (TID-7684(p.55-7)) IRRADIATION OF FRUITS AND VEGETABLES IN A MOBILE COBALT 60 UNIT. John M. Harvey (Department of Agriculture. Agricultural Marketing Service, Fresno, Calif.).

A mobile $^{60}Co$ unit is described that contains 40,000 C $^{60}Co$ and with which a typical dose of 200,000 rads requires a dwell time of 40 min. Several fruits, vegetables, and insects were treated with the unit; work done with the insects is reported. About 120 insects of each stage of development were treated by seven dosages and five replications in each experiment. Findings indicate variations in radiosensitivity of the various species studied, the most sensitive being the confused flour beetle that requires less than 10,000 rads for a sterilizing dose (one which will disrupt the life cycle). The cigarette beetle, black carpet beetle, and Trogoderma beetle were found to be intermediate in susceptibility; whereas the Indian meal moth was comparatively resistant, requiring 50,000 rads for a sterilizing dose. In general, the older a specimen was in each of the stages of development, the less susceptible it was to irradiation. (H.M.G.)

**22200** (TID-7684(p.81-2)) IRRADIATOR DESIGN STUDIES AT BROOKHAVEN NATIONAL LABORATORY. Otto A. Kuhl (Brookhaven National Lab., Upton, N. Y.).

During the past year conceptual design studies for a Bulk Grain Irradiator and a Shipboard Marine Products Irradiator were carried out and reported in BNL 810 (T-312) and BNL 808 (T-311), respectively. Specifications are presented for both irradiators. (auth)

**22201** (TID-7684(p.135-54)) DEVELOPMENT OF IRRADIATION FACILITIES. George R. Dietz (Atomic Energy Commission, Washington, D. C.).

A major portion of the AEC food irradiation program is devoted to the development of a family of radiation facilities. First, research irradiators capable of supporting food irradiation studies were designed and constructed. Current emphasis is on proto-commerical facilities either under design or construction, or planned for construction as the program develops. Proto-commercial facilities are intended to translate laboratory data to semi-production or pilot plant operation to prove laboratory data on a near commercial scale, and to aid in the determination of the economics involved. Included in this category are mobile units, a Marine Products Development Irradiator (MPDI), and a grain irradiator. Types of irradiators classed as highly specialized, or applicable in unique situations, constitute another category. Detailed discussion is presented on a research irradiator, transportable units, the grain irradiator, central or inplant irradiators such as the MPDI, on-board ship irradiators, the Hawaiian irradiator, and the U.S. Army Radiation Laboratory at Natick, Massachusetts. (H.M.G.)

**22202** (TID-20584) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 1, May 1963. (Babcock and Wilcox Co., Barberton, Ohio). June 20, 1963. Contract AT(11-1)-1280. 32p.

In addition to discussing the progress on the various phases of the work, the report covers some general design criteria. The scope of the work is as follows: preliminary design of 1000 Mw steam generator; supporting research and development; preliminary design of 30 Mwt prototype steam generator; detail design of 30 Mwt prototype; and fabrication of prototype for installation. (auth)

**22203** (TID-20585) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 3, July 1963. (Babcock and Wilcox Co., Barberton, Ohio). Sept. 3, 1963. Contract AT(11-1)-1280. 43p.

The report contains some information on: preliminary design of full-size steam generator; supporting R&D work; and preliminary design of 30 Mwt prototype steam generator. (auth)

**22204** (TID-20586) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 4, August 1963. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 56p.

This report contains some information on: preliminary design of full-size steam generator; supporting R&D work; and preliminary design of 30 Mwt prototype steam generator. (auth)

**22205** (TID-20587) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 5, September 1963. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 59p.

This report contains some information on: preliminary design of full-size steam generator; supporting R&D work; and preliminary design of 30 Mwt prototype steam generator. (auth)

**22206** (TID-20588) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report No. 6, October 1963. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 64p.

This report contains some information on: preliminary design of full-size steam generator; supporting R&D work; and preliminary design of 30 Mwt prototype steam generator. (auth)

**22207** (USBM-U-1109(p.16-18)) THERMODYNAMICS OF COLD-MOLD ARC MELTING. (Bureau of Mines. Albany Metallurgy Research Center, Ore.).

Experimental measurements of heat transfer rates through a water-cooled copper crucible were scaled up from 1 to 1-$^3/_8$ inch-diameter. The maximum rate does not seem to be significantly different. The technique and apparatus for measuring the thermal resistance of the surface of a copper crucible wall were essentially stabilized. Data-collection trials have begun, with special attention to establishing limits of accuracy. (auth)

**22208** (AERE-Trans-901) CURRENT-LIMITING HIGH-SPEED SWITCHES FOR HEAVY-CURRENT INSTALLATIONS. A. Erk. Translated by W. G. Stripp (U.K.A.E.A. Research Group. Harwell, Berks, Eng.), from Elektrotech. Z. B., 14: No. 7, 169-74(1962). 20p.

The techniques commonly used to avoid or limit large short-circuit currents in heavy-current installations are briefly described, and the performance required of high-speed, current-limiting switches is stated. Possible arrangements for meeting the requirements are then discussed. Essentially, the state of the art is reviewed. (D.C.W.)

**22209** CHARACTERISTICS OF FIELD EMISSION CATHODE. Takeo Okada, Shin-ichi Aoki, and Akio Yamanaka. Mitsubishi Denki Lab. Rept., 4: 237-46 (Apr. 1963).

Stability and maximum allowed current of field emission cathode are checked experimentally. This experiment is made with the diode tube which has a tungsten emitter $0.1 \sim 0.4\mu$ tip radius with the pressure of the order of $10^{-10}$ Torr. The results are as follows: Emitter suffers emission slump by gas contamination at room temperature, even with the pressure of $10^{-10}$ Torr, but this surface can be kept nearly clean by maintaining the tip temperature at 1300°C or higher. Emitter is apt to deform at high temperature by migration effect, and it is very difficult to keep constant form of the emitter in balanced condition. In the pressure of $10^{-9}$ Torr or more, sputtering of emitter material is distinguished by ion bombardment, and it makes to damage emitter shortly. Practically, this emitter is effective to use in pulse operation at high temperature. (auth)

**22210** A STUDY OF DIFFERENT DESIGNS OF COLD ELECTRON SOURCES CAPABLE OF MASS SPECTROMETRIC APPLICATIONS. M. K. Testerman, R. W. Raible, G. W. Grimes, J. R. Williams, and B. E. Gilliland (Univ. of Arkansas, Little Rock). 17p. (CONF-74-26)

From 11th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963.

The development of mass spectrometric ion generation sources using electron multipliers in conjunction with both beta-emitting materials and photoelectrons is discussed. It is shown that such a source is characterized by low temperature operation, high ionization efficiency, and an electron energy distribution that does not change with multiplier gain variations. (C.E.S.)

**22211** INVERSIONS OF SLOWLY RADIATING STATES IN DISCHARGES. P. J. Walsh and G. E. Courville. 7p. (CONF-364-8)

From 16th Annual Gaseous Electronics Conference, Pittsburgh, Oct. 1963.

The population of high atomic states in discharges in gaseous lasers and the possible inversions among these levels and between these levels and the ground state are considered. These populations and inversions for slowly radiating states are considered for two cases. The presence of a Maxwellian electron energy distribution and the presence of an extremely narrow electron energy distribution in a discharge are considered. It is shown that for a Maxwellian distribution, inversions of a slowly radiating state lying above a rapidly radiating state are a rather natural consequence in many discharges. For a narrow energy distribution the results indicate that inversion of weakly radiating states over the ground state may also be possible. (C.E.S.)

**22212** MASTER AND SLAVE ARM MANIPULATING APPARATUS. Irvin Richard Grainger (to Pye Ltd.). British Patent 954,014. Apr. 2, 1964. Filed Jan. 15, 1960.

A master-slave remote-handling device is described. The slave unit has receptacles for holding various tools; these tools can be interchanged by the slave unit itself. (T.F.H.)

**22213** A RAPID OCCULTATION DEVICE FOR A RADIOACTIVE SOURCE. (to Institut de Recherches de la Siderurgie Francaise). British Patent 957,141. May 6, 1964. Priority date Nov. 7, 1961, France.

A pneumatic device is described for rapidly moving radioactive sources to the position in which they are used from the position in which they are heavily shielded, and vice versa. The device may be either single- or double-acting. (T.F.H.)

**22214** DETACHABLE FLANGED JOINT FOR COAXIALLY EXTENDED PIPES USED IN NUCLEAR REACTORS. (to Beteiligungs- und Patentverwaltungsgesellschaft mit beschrankter Haftung and Brown, Boveri and Cie AG). German Patent 1,160,247. Dec. 27, 1963. Filed Mar. 17, 1961.

The detachable flanged joint described is for a duct comprising an outer pipe member enclosing an inner pipe member to define an outer fluid flow duct and an inner fluid flow duct. The flanged joint comprises two gaskets for the inner and outer pipe, respectively, which are compressed when the flanges are screwed together. An essential feature of the joint is that there is a loose flange pulley between the fixed flange pulleys. The loose pulley is for compressing the gasket of the outer pipe. (Gemlin Inst.)

**22215** WALL LEAD-IN FOR SUPPLY LINES AND MOVABLE LINKS. Hugo van den Bergh (to Leybold-Hochvakuum-Anlagen GmbH). German Patent 1,161,730. Jan. 23, 1964. Filed Nov. 19, 1960.

A device for the introduction of supply lines or movable links through openings of walls of hot cells is described. This device comprises a replaceable air-tight jacket that is partly fitted into the opening. As the remaining part of the jacket is stepped, a ring-shaped space is formed between this part of the jacket and the opening. An air-tight insert is fitted into the space between the stepped part of the jacket and the inner surface of the opening. An essential feature of the device is that the steps of the insert are arranged in such a way that the step with the largest diameter is on the outside of the shield. (Gmelin Inst.)

**22216** MANIPULATOR. Jean-Claude Mettetal and Georges Fritz (to Electricite de France-Service National). German Patent 1,162,529. Feb. 6, 1964. Priority date July 28, 1959, France.

A manipulator is described that performs gripping and grasping operations as well as the transportation of objects within and out of or into the working area. The manipulator comprises a U-iron support extending through a horizontal tube in a generally vertical shielding wall, a main arm resting slidably on the support, a second arm pivotally mounted at the end of the main arm, which may be rotated about a vertically arranged pivot, and a claw arm pivotally mounted at the end of the second arm, which may be rotated about a horizontally arranged pivot. The second arm and the claw arm can be moved into a horizontal alignment with the main arm. In this position the main arm acts as a self-propelled car that moves through the tube in a known manner. As the electric drive motors for the movement of the arms are mounted within the arms and the drive motor for activating the claw does not project above the tube, the manipulator can move through fairly narrow tunnels. (Gmelin Inst.)

**22217** VIEWING SYSTEM FOR PRESSURIZED AND HIGH-TEMPERATURE HOT CELLS, e.g. NUCLEAR REACTORS. Hans Waelischmueller. German Patent 1,165,778. Mar. 19, 1964. Filed Oct. 19, 1961.

A composite viewing system is described consisting of one or more control windows installed into openings of the wall of the cell and, for direct viewing, of a shielding window adjacent to the control windows and installed into an opening of the biological shield, or, for indirect viewing, of a periscope with the objective located in front of a control window and the ocular located behind the shield. As the diameter of the control windows can be kept small, the thickness of these windows is practically equal to the thickness of the wall of the pressurized cell. (Gmelin Inst.)

**22218** MECHANICAL MANIPULATORS FOR THE DISPLACEMENT OF OBJECTS LOCATED IN A RADIOACTIVE MEDIUM. Rene Le Guennec and Pierre Persenti (to Commissariat a l'Energie Atomique). U. S. Patent 3,128,887. Apr. 14, 1964. Priority date Feb. 25, 1960, France.

A mechanical manipulator consists of a pilot member and a controlled member disposed on either side of one of the walls of an enclosure surrounding a radioactive medium. Articulated parallelograms connected to each member are deformable in parallel planes and connected by one of their corners by concentric tubes perpendicular to the planes and relatively rotatable. An outer tube is slidably and rotatably mounted within the wall of the enclosure. Concentric tubes are disposed inside this tube according to the movements to be transmitted from the pilot member to the control member. Each tube is rotatably mounted with respect to the others and integral in rotation at each end with a pulley connected by a cable system to one of the axes about which the movements are effected. The sealing of the transferred movement can be ensured by a flexible bellows sleeve fixed by one end to the outer tube on the controlled side and by the other end to a concentric tube surrounding the first and located in the wall of the enclosure. Sealing for other movements is effected by rotary joints appropriate to the tightness of the seal required and to the sensitivity required for the movements. (A.G.W.)

**22219** WAX JET SHUTTER. John C. Cast and Orville G. Winslow (to U. S. Atomic Energy Commission). U. S. Patent 3,133,485. May 19, 1964.

A camera shuttering device comprising a mass of wax having a conical depression at one end and explosive means at the other end whereby actuation of the explosive means causes a high velocity jet of wax to issue from the depression and impinge upon the camera window is described. (AEC)

## Heat Transfer and Fluid Flow

**22220** (GEAP-4576) TWO-PHASE PRESSURE LOSSES EIGHTH QUARTERLY PROGRESS REPORT, NOVEMBER 12, 1963–FEBRUARY 11, 1964. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Mar. 1, 1964. Contract AT(04-3)-189. 11p.

Voids were measured in a 0.5 by 1.75 in. channel with the S-1 insert ($B_0/B_1 = 0.4$, $L_0 = 0.1$ in.), at 2 in. ahead of the insert (position A), 0.5 in. past the insert (position B), 5 in. past (position C), and 12 in. past (position D). The conditions were: $P = 1000$ psia, $G = 1.00 \times 10^6$ lb/h-ft$^2$, and $x = 18.8\%$. Average void and void distribution at position A were the same as for flow in a straight channel. Void distribution at position B showed that the stagnation region downstream of the inserts contains a high fraction of voids. Average void and void distribution at positions C and D showed that the two-phase mixture becomes strongly mixed (homogenized) as a result of passing through the contraction-expansion inserts. Distribution at position D approached the distribution at position A; i.e., the straight channel distribution. Full reestablishment of the flow had to occur downstream of position D. (auth)

**22221** (GEAP-4608) TRANSITION BOILING HEAT TRANSFER PROGRAM. Quarterly Progress Report No. 5, January–March 1964. E. P. Quinn (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 19p. (EURAEC-1035)

Tests with the two-rod assembly were performed with liquid film trippers attached to the unheated wall, and a variation in rod spacing. Experimental data and improved high-speed motion pictures were obtained of transition boiling behavior. The changes of the local heat transfer process between nucleate and film boiling can be readily distinguished in the motion pictures. Observational tests performed with very short fins on the heated surface resulted in essentially eliminating transition boiling temperature fluctuations and doubling the film boiling coefficient. These gains were attained without reduction of the critical heat flux. (auth)

**22222** (IS-738) EMISSION SPECTROSCOPIC TECHNIQUES IN TURBULENT MASS TRANSFER STUDIES. Alan Melvin Bekelman and Ray Fahlen (Ames Lab., Ames, Iowa). May 1963. Contract W-7405-eng-82. 118p.

It was indicated that in order to obtain accurate point values of the radial turbulent diffusion coefficient ($E_r$) and axial turbulent diffusion coefficient ($E_z$) simultaneously, one should solve the unsteady state continuity equation, and therefore unsteady state point concentration data are required. Previous studies of the steady state concentration profile in the diffusion column to be used demonstrate the desirability of measuring concentrations in the range from 0.1% to 10% $CO_2$ in air. The speed and adaptability of the emission spectroscopic method led to its selection as a possible technique for obtaining the desired gas phase unsteady state point concentration data. A feasibility study utilizing a Cornu prism spectrograph with a photographic technique, and a Tesla coil as power source to a spark gap analysis cell, showed that steady state concentration data for $CO_2-N_2$ and $CO_2-$air mixtures could be obtained in the concentration range above 0.4% $CO_2$ in the mixture at essentially atmospheric pressure. From the spectroscopic plates, the un-ionized carbon line (2486 Å) and the nitrogen band head (3134 Å) were selected to represent the $CO_2$ concentration and the internal standard, respectively. The spectrograph was converted to a direct reading instrument, using photomultiplier tubes to measure the intensity of the radiation at the wavelengths selected for the calibration. Reproducible data were obtained for gas mixtures of concentrations from 100 to 0.5% $CO_2$ in air at essentially atmospheric pressure. A d-c power source was used in an attempt to extend the lower limit of the detectable concentration range. For the first time the intensity of the unionized carbon line was observed, on a photographic plate, for air (0.03% $CO_2$). Thus, the lower detectibility limit for the time integrated (steady-state) point concentration data obtained by the photographic technique was extended down to an acceptable limit. This photographic data also indicates that it should be possible to extend the range in which the spectroscopic data may be taken with the proper direct reading equipment down to 0.03% $CO_2$ in air. The spectroscopic technique using a d-c power source was found to be free from the stray electromagnetic radiation problems involved in using the Tesla coil power supply. Reproducible data were obtained over the same concentration range as in the Tesla coil power direct reading spectroscopic study. The emission spectroscopic spark gap technique was found to be independent of flow rate. It is recommended that a photomultiplier tube of high blue sensitivity and a control gap be employed with the d-c power supplied spectrographic technique to obtain the desired unsteady-state point concentration data. This technique, a universal method of gas analysis capable of yielding time-dependent point concentration data, should also be of interest in combustion studies, gas-phase kinetics studies, respiratory studies, aviation medicine, and in frequency response experiments. (auth)

**22223** (SGAE-RE-1/1964) DYNAMISCHE UNTERSUCHUNG DES WARMEAUSTAUSCHERS. 2. ARBEITSBERICHT 1963. (Dynamic Studies of Heat Exchange. 2. Work Report, 1963). (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Vienna). 143p.

Theoretical principles and investigations of axial heat exchange in a tube are discussed. The theory of heat transfer in a water-to-water heat exchanger without formation of steam is considered and the design of equipment is described. Plans for equipment for heat transfer in a heat exchanger by water-steam mixtures are outlined. (M.C.G.)

**22224** (AEC-tr-6393) CRITICAL HEAT FLUXES IN CIRCULAR CHANNELS. V. I. Subbotin, B. A. Zenkevich, and G. V. Alekseev. Translated for Westinghouse Electric Corp., Bettis Atomic Power Lab., Pittsburgh), from Teploenerg., No. 10, 72-5(1963). 8p.

The results of an experimental investigation of critical heat fluxes for the forced motion in circular channels of subcooled water and a steam–water mixture in the pressure range 100 to 180 atm are presented. (auth)

**22225** (EURAEC-793) DETERMINATION OF THE LAW OF EXCHANGE ON A NONISOTHERMAL SURFACE. Special Technical Report No. 1. (Compagnie Francaise Thomson-Houston, Paris). [nd]. Work performed under United States–Euratom Joint Research and Development Program. Contract 050-62-5RD-C. 37p. (A translation)

Studies were made to determine the density of the thermal flux exchanged by boiling on a partition that is essentially nonisothermal, as a function of the difference between the temperature of the wall and the saturation temperature of the liquid. On a sample of large dimensions and of fair thermal conductivity operating by Vapotron effect, the "Nukiyama curve" was retained. (M.C.G.)

**22226** (EURAEC-794) NUCLEAR VAPOTRON. Special Technical Report No. 2. (Compagnie Francaise Thomson-Houston, Paris and Société Alstrom, Paris). [nd]. Work performed under United States–Euratom Joint Research and Development Program. Contract 050-62-5RD-C. 66p. (A translation)

Two methods utilizing thermocouples for measuring temperatures in "Vapotron" can walls were compared. Defects in these methods were overcome by cutting a groove with a width equal to that of the outer diameter of the thermocouple can and a depth of the same order of magnitude in the Vapotron can. The thermocouple is loaded into the recess and a mechanical means is used for adjusting the machinery rims and partially deforming the couple in order to adapt the couple to the shape of the recess. (M.C.G.)

**22227** (ORNL-tr-90) HEAT CONDUCTION IN INSULATORS. G. Leibfried. Translated for Oak Ridge National Lab., Tenn., from p.290-316 of the Encyclopedia of Physics, Volume II, Section H, Part I. [nd]. 43p.

Heat conductivity in crystalline electric insulators is investigated. Only defect-free lattices are considered. The coupling of lattice waves among themselves, the coupling of electron waves among themselves, and the coupling of electrons with lattice waves are discussed. (C.E.S.)

**22228** STRUCTURE OF VERY HIGH THERMAL CONDUCTANCE. G. M. Groover, T. P. Cotter, and G. F. Erickson (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 35: 1990-1(June 1964). (LADC-6116)

The design and operation of capillary structures for returning the condensate to the evaporator in heat transfer systems are discussed. The heat pipes may be regarded as synergistic engineering structures that are equivalent to a material having a thermal conductivity greatly exceeding that of any known metal. The performance of a sodium heat pipe is described. (C.E.S.)

**22229** ON THE CALCULATION OF TEMPERATURE DISTRIBUTIONS IN CYLINDRICAL REACTOR FUEL ELEMENTS. Adolf Birkhofer (Technische Hochschule, Munich) and Frank Heymann. Nukleonik, 6: 77-87(Mar. 1964). (In German)

In previous work it was shown that both stationary and unstationary heat transfer problems for sources can be solved by means of the classical method of eigen functions. For these problems the source distribution can be estab-

lished by simple proportions. The described method of solution allows also for use of essentially complicated source functions. Beyond that several dimension problems could also be treated in optional geometry by the same method. The boundary conditions could be assumed insofar as inhomogeneity was concerned, and, by suitable transformation, for homogeneity. For calculation of the considered heat transfer problems three programs for the electronic data processing installation ZUSE Z23 were written and used for calculation of an example chosen for the practice. It was found that the sums or double sums appearing in the solution converge proportionately rapidly. The necessary calculation time is therefore less, so that the calculation can be carried out easily also on small and average calculation installations. (tr-auth)

**22230** PROCEEDINGS OF THE SYMPOSIUM ON TWO-PHASE FLUID FLOW, 7TH FEBRUARY 1962. London, The Institution of Mechanical Engineers, 1962. 121p.

Eleven papers are included. Information is included on theoretical and experimental studies on flow regimes and mechanisms and their influence on heat transfer and burnout in heated tubes; flow through tubes; experimental data relating to pressure drop in two-phase flow; and on circulation considerations in both conventional and nuclear circulation loops. (P.C.H.)

**22231** ADVANCES IN HEAT TRANSFER. VOLUME 1. Thomas F. Irvine, Jr., and James P. Hartnett, eds. New York, Academic Press, 1964. 466p. $16.00.

The interaction of thermal radiation with conduction and convection heat transfer, application of integral methods to transient nonlinear heat transfer, heat and mass transfer in capillary-porous bodies, boiling, the influence of electric and magnetic fields on heat transfer to electrically conducting fluids, and fluid mechanics and heat transfer of two-phase annular-dispersed flow are discussed. Separate abstracts were prepared for the sections on boiling and heat transfer to electrically conducting fluids. 430 references. (R.E.U.)

*For abstracts of individual papers see: 22232 and 22233.*

**22232** BOILING. G. Leppert and C. C. Pitts (Stanford Univ., Calif.). p.185-266 of "Advances in Heat Transfer. Vol. I." New York, Academic Press, 1964.

Nucleation and bubble dynamics, nucleate boiling, and critical heat flux are discussed. 93 references. (R.E.U.)

**22233** THE INFLUENCE OF ELECTRIC AND MAGNETIC FIELDS ON HEAT TRANSFER TO ELECTRICALLY CONDUCTING FLUIDS. Mary F. Romig (RAND Corp., Santa Monica, Calif.). p.267-354 of "Advances in Heat Transfer. Vol. I." New York, Academic Press, 1964.

Magnetohydrodynamics and heat transfer are discussed. The basic equations and boundary conditions of MHD are presented. Thermal instability in free convection in electrostatic fields, heat transfer in channel flow, flat-plate boundary-layer heat transfer, and heat transfer to blunt bodies are considered. 82 references. (R.E.U.)

## Materials Testing

*Refer also to abstract 23090.*

**22234** (HW-77831) FATIGUE TESTING MACHINES—NPR PIPE SEAM WELD EVALUATION. W. J. Love (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 8, 1962. Contract AT(45-1)-1350. 10p.

Two machines, which were constructed to test seam weld samples from 18-in. NPR pipe, are described. The hydrostatic test machine stresses the seam weld specimen by means of a cyclic uniaxial, direct, zero to maximum tensile load. The vibratory fatigue machine stresses weld specimens by means of alternating, uniaxial, tension-compression bending load. Both machines are designed to stress a 2.00-in. long section of the pipe. (M.C.G.)

**22235** (MAB-196-M) RECOMMENDED QUALITY STANDARDS FOR TUNGSTEN SHEET PRODUCED IN THE REFRACTORY METALS SHEET ROLLING PROGRAM. (National Research Council. Materials Advisory Board). Jan. 22, 1964. 23p.

Quality standards recommended for identification, sampling, testing, visual inspection, dimensional tolerances, sonic inspection, chemistry, tensile properties, bend tests, and metallography and hardness of tungsten sheet are given. A form sheet report is included. (P.C.H.)

**22236** PHOTOSENSITIVE HOLE DETECTOR USING PHOSPHOR RADIATION SOURCE. Erich Scharf and Jack Fajans (to Cutler-Hammer, Inc.). U. S. Patent 3,128,385. Apr. 7, 1964. Filed Feb. 18, 1959.

An apparatus suitable for detecting holes in sheet material traveling at a relatively high speed utilizes an ultraviolet light source for illuminating one side of the sheet. One or more photoelectric units is mounted to receive light passing through the sheet. A filter assembly mounted between the scanned area and the photoelectric unit is adapted to transmit substantially only ultraviolet radiation. A phosphor layer is positioned to receive ultraviolet radiation passing through the filter and emit radiation for exciting the photoelectric units. Means responsive to the photoelectric unit provides a signal when a hole in the material passes through the scanned area. An arrangement for automatically shifting the scanned area in step with lateral drifting of the work is included. (A.G.W.)

## Protective Structures

**22237** (AD-426950) BLAST AND SHOCK BIOLOGY AS RELATED TO UNDERGROUND STRUCTURES. [Period Covered]: January 1953–December 1963. Samuel A. Tancredi, comp. (Defense Documentation Center, Arlington, Va.). Dec. 1963. 42p.

An annotated bibliography consisting of 95 references is presented. (H.M.G.)

## Vacuum Engineering

**22238** INVESTIGATIONS ON THE ECONOMIC PRODUCTION OF ULTRA-HIGH VACUUM. H. Blank, H. Bollinger, and K. Petzold. Exptl. Tech. Physik, 12: 49-57 (1964). (In German)

It is shown that a glass apparatus in less than 8 hours can attain a pressure of $10^{-10}$ torr. Under certain assumptions only a diffusion pump and cooling are necessary. As a result of this investigation a commercial pump is described. (tr-auth)

**22239** SOME EXPERIMENTS ON THE EFFECTS OF BACKSTREAMING AND OF BACK-DIFFUSION ON THE

PRODUCTION OF ULTRA HIGH VACUUM. Atsushi Fujinaga, Takao Hanasaka, and Hiroshi Tottori. Mitsubishi Denki Lab. Rpt., 4: 225-36(Apr. 1963).

A vacuum system with two oil diffusion pumps connected in series was constructed for obtaining the experimental data about backstreaming and back-diffusion. These two pumps were of the same type, and the one was used as a main pump and the other was used as a booster pump to supply the main pump with good fore vacuum. The behavior of backstreaming of oil vapor was investigated by the omegatron type mass spectrometer, and this observation indicated that the oil vapor flowing through a pipe can not be treated as a steady flow, but it has to be treated as an unsteady flow having a tendency to drift into a pipe gradually. The speed of the drift seems to be very slow, and for that reason, the partial pressure of oil vapor in a vacuum chamber apart from the pump can be kept lower than the vapor pressure for several months. Several kinds of known gases such as hydrogen, helium, etc. were introduced separately into the fore vacuum line of the main pump and the masses in the high vacuum line were investigated by the omegatron. The observed compression ratio of the main pump was of the order of $10^3$ for light masses ($H_2$ and He), and this ratio increased to about $10^5$ in the case of neon. For nitrogen, the compression ratio increased to more than the order of $10^7$ so that the back-diffusion could not be observed at all. (auth)

**22240** MECHANICAL VACUUM PUMP COLD TRAP. Richard W. Bailey (Ohio State Univ., Columbus). Rev. Sci. Instr., 35: 644(May 1964).

A simple inexpensive dry ice cold trap that eliminates the oil vapor problem encounted when mechanical pumps are used with solid-state radiation detectors is described. (R.E.U.)

**22241** ION PUMPING MECHANISM IN ARGON AND NITROGEN. G. Carter (Univ. of Liverpool). Vakuum-Tech., 12: 47-54(Mar. 1963). (In German)

The ion pumping of argon and nitrogen at the glass walls of a Bayard-Alpert gage was studied. Measurements of maximum pumping speeds and the maximum sorbed quantity are given for the gases, and it is shown how the values for $N_2$ may be an order of magnitude larger than for argon, although the physical reasons are not understood. A mathematical approach to the problem, involving ion capture and release probabilities, is shown to lead to intractable analytic conclusions unless very serious simplifications are made. The lack of simplicity is believed to render a quantitative approach to the problem almost useless. (auth)

**22242** HIGH VACUUM ENGINEERING. Alfred E. Barrington. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1963. 219p. $10.95.

An introduction to practical high-vacuum system design is presented. Theory and applications of sputter-ion and sorption pumps are discussed. The contents include mechanical and jet-type vacuum pumps, vacuum gages, cryopumps, gas analysis and leak detection, and an introduction to kinetic theory of gases. (R.E.U.)

**22243** ULTRAHIGH VACUUM AND ITS APPLICATIONS. Richard W. Roberts and Thomas A. Vanderslice. Series in Solid State Physical Electronics. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1963. 217p. $10.00.

Ultrahigh vacuum technology for experimental scientists, engineers, and technicians is discussed. Topics covered include components and types of vacuum systems, materials of construction, generation of clean surfaces, physical properties of surfaces including thermionic emission and electron diffraction, and some applications. Numerous illustrations and references. (R.E.U.)

# GEOLOGY AND MINERALOGY

## General

**22244** (CONF-498-2) MEASURED DEPOSITION RATES OF MARINE SEDIMENTS AND IMPLICATIONS FOR ACCUMULATION RATES OF EXTRA-TERRESTRIAL DUST. William M. Sackett (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). [1963]. Contract AT (30-1)-3139. 12p.

From Geological Society of America 1963 Annual Meeting, New York, Nov. 1963.

Accumulation rates of deep sea sediments were measured by determining the radioactive decay of $^{14}C$, $^{230}Th$, and $^{231}Pa$. Various methods for determining accumulation rates were compared on a core from the abyssal hills halfway between the Mid-Atlantic Ridge and the Canary Islands. Paleontological examination of this core indicated that only normal particle-by-particle sedimentation had occurred. The top parts of other cores were also analyzed. On the basis of measured deposition rates of deep sea sediments, the average rate of accumulation of extra-terrestrial material over the past few thousand years was calculated to be less than or equal to about 0.1 cm/1000 yr. Using the estimate of $10^4$ tons/day as the amount of cosmic dust being added to the earth at the present time, only 1% or less of marine sediment has a cosmic origin. (C.H.)

**22245** DETERMINATION OF VOLUMETRIC WEIGHT OF SOILS BY MEANS OF GAMMA RADIATION SOURCE. Jerzy Niewodniczanski (Akademia Gorniczo-Hutnicza, Poland). Przeglad Geol., 12: 30-4(1964). (In Polish)

The knowledge of physical properties of grounds under conditions of their natural occurrence is basic to project and to conduct various ground works and building constructions. Among the most important coefficients characteristic of ground environment there are: humidity, moisture content, volumetric weight, porosity, and degree of compactness. Determination of these properties using classical methods is very difficult. The radiometric methods of determining the volumetric weight of ground are presented. The methods are based on the existing gamma radiation sources. It is possible when knowing the humidity of ground, to compute the porosity immediately. The radiometric measurement of humidity is based on the phenomena of mutual relations of neutrons and environment substances. The application of these methods in engineering geology will be presented in a later article. (auth)

## Natural Radioactivity and Fallout

*Refer also to abstracts 22308 and 23072.*

**22246** (UCRL-7716) CALCULATION OF RADIOACTIVE IODINE CONCENTRATIONS IN MILK AND HUMAN THYROID AS A RESULT OF NUCLEAR EXPLOSIONS. Ralph A. James (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 14, 1964. Contract W-7405-eng-48. 20p.

The production and distribution of radioactive I by nuclear explosions are discussed. Equations and graphs are presented by which the levels of $^{131}I$ and $^{133}I$ corresponding to the Federal Radiation Council (F.R.C.) guide can be determined. The fallout level, intake by cows, concentration in milk, and content of the human thyroid are considered. It is concluded that the maximum concentration in milk as the result of a single event which corresponds to F.R.C. guide is approximately 2800 pC/l. (auth)

**22247** (UR-641) BACKGROUND GAMMA SPECTRA IN A SALT MINE. Albert Rieder and Charles Scholes (Rochester, N. Y. Univ. Atomic Energy Project). Mar. 9, 1964. Contract W-7401-eng-49. 22p.

In the search for a natural, low gamma background environment, measurements were made in a salt mine with a NaI crystal detector and a multichannel analyzer. The results were compared with similar measurements in the laboratory under a variety of conditions. In general terms, the gamma gackground in the mine proves to be about 14 times lower than the unshielded laboratory measurements and about twice the background obtained in the laboratory with the detector surrounded by 8 in. of steel. (auth)

**22248** (JPRS-24281) STRONTIUM-90 IN THE SURFACE WATERS OF THE ATLANTIC OCEAN IN THE FIRST HALF OF 1961. E. G. Azhazha and P. M. Chulkov. Translated from Okeanologiya, 4: 68-73(1964). 10p. (OTS-64-31117)

Strontium-90 content was measured in surface waters of the Atlantic Ocean along the 30th meridian W during the first half of 1961. Samples were taken between 40°N and 30°S latitude. Samples were also taken in the North Sea and Baltic Sea. The $^{90}Sr$ varied from 6 to 20 decays/min/100 l water sample. In the North Sea and the Baltic Sea the surface concentrations of $^{90}Sr$ were 22.9 and 45.3 decays/min/100 l sample. This was attributed to the high levels of fallout of $^{90}Sr$ from the atmosphere. (C.H.)

**22249** (JPRS-24435(p.305-8)) THE MAINTENANCE OF ISOTOPIC ABUNDANCE IN THE FORMATION OF ELEMENTS. P. G. Parkhomenko. Translated from Vopr. Kosmogonii, Akad. Nauk SSSR, 6: (July 19, 1958). 4p.

It was previously shown that in a thermonuclear medium at temperatures above $10^{8.5}$°K, photodisintegration will obstruct the radiative capture of nucleons by the nuclei of light elements. These nuclei therefore remain in the frozen state. It is shown that if the temperature falls below $10^{8.5}$°K, the life of a nucleus between two successive captures will be of the order of $10^4$ years, during which time total rarefaction and cooling of the medium can take place. (auth)

**22250** (JPRS-24435(p.316-17)) THEORIES OF THE "EQUILIBRIUM" ORIGIN OF ELEMENTS. S. B. Pekel'ner. Translated from Vopr. Kosmogonii, Akad. Nauk SSSR, 6: (July 19, 1958). 2p.

The synthesis of complex atoms from simple ones and the explanation of the existing abundances of various chemical elements are considered. (C.E.S.)

**22251** SORPTION OF RADIOCESIUM BY SOIL. Hwa-sheng Cheng (Tsing Hua Univ., Hsinchu, China) and Hiroshi Hamaguchi. J. Chinese Chem. Soc. (Taiwan), 10: 200-9(Dec. 30, 1963).

The sorption of radiocesium (Cs-134) by seven different samples of soil was studied over a wide pH range (0-14). In general, the sorption is excellent except in the low pH region. The presence of 0.01 N $Na^+$, $Mg^{2+}$, $Ca^{2+}$, $Sr^{2+}$, $Ba^{2+}$ and $Al^{3+}$ does not seem to influence either the uptake of radiocesium by, or the extraction of the sorbed radiocesium from, red soil and yellow soil. (auth)

**22252** MORE RADIOACTIVITY IN MILK. Lancet, 1: 420-1(Feb. 22, 1964).

The rise in $^{90}Sr$ and $^{137}Cs$ levels in milk in the United Kingdom during 1963, especially in certain sites, is discussed. At these sites levels of contamination are expected to exceed the average appreciably. These special sites are farms, or small groups of farms, usually in sparsely populated parts of the country where the deposition of $^{90}Sr$ is heavy because rainfall is high and where characteristics of unproductive pastures cause enhanced transfer to milk. The sites are not representative of areas of high rainfall generally nor of normal conditions in the counties in which they are situated. The mean $^{90}Sr/Ca$ ratio in milk produced in 1963 at 32 special sites ranged from 50 to 210 pC/g, compared with the national average of 26 pC/g. The largest single figure was 470 pC/g from a Caernarvonshire (Wales) site. At special sites the mean $^{137}Cs$ concentrations for 1963 ranged from 340 to 1250 pC/l, while the national average was 135 pC/l. The mean levels of $^{90}Sr$ recorded in bone in the age-group 1 to 2 yr for the years 1959, 1960, 1961, and 1962, and the first half of 1963 were respectively 3.9, 3.4, 2.5, 2.4, and ~4 pC/g Ca. These levels are only small fractions of the maximum permissible level suggested for the general population (67 pC/g), and all the individual measurements in bone are small fractions of the recommended maximum permissible level for individual members of the population (200 pC/g). It is estimated that the maximum level which could be reached in the bones of any individual infant continuously exposed to the most adverse local $^{90}Sr$ contamination to date would be about 50 pC/g (equivalent to a radiation dose rate to bone of about 140 mrem/yr). On the same basis, the mean level of $^{90}Sr$ in the bones of young children in the population of any large region of the country is not expected to reach 10 pC (about 30 mrem/yr), and the countrywide average will be not more than 7 pC (about 20 mrem/yr). (BBB)

**22253** MORE RADIOACTIVITY. Lancet, 2: 819 (Oct. 19, 1963).

An Agricultural Research Council survey of radioactivity in human diet in the United Kingdom shows that after the resumption of weapon tests in northern latitudes during September, 1962, $^{131}I$ appeared in appreciable amounts in milk until early December, after which it fell away rapidly, the decline being hastened by the snow. From January to the end of June, 1963, the $^{131}I$ level was below the limit of detection (11 pC/l) in all samples. The Medical Research Council (MRC) states that an acceptable dose of $^{131}I$ would not be exceeded in any age group unless the average concentration in milk exceeded 130 pC/l. The figures for the year ending June 1963, indicate that the countrywide average value was 14.6% of the MRC specification, with a maximum of 20% in Scotland. The monthly depositions of $^{90}Sr$ in rain at Milford Haven for the years 1958–62 were (as $mC/km^2$): 1958, 5.38; 1959, 5.73; 1960, 1.77; 1961, 2.47; 1962, 9.33. Thus, weapon testing of 1961 made 1962 the heaviest year yet for $^{90}Sr$ deposition at Milford Haven, and when allowance is made for differences in rainfall, measurements at Milford Haven indicate the situation throughout the country. The countryside milk survey also reflected this increase in Sr fallout. For the 12 months ending June, 1963, the average ratio of $^{90}Sr/Ca$ in milk was about 15 pC/g, the highest 12-month mean value since the survey began. The previous highest values in 1959, were about 20% lower than those for 1962. The mean ratio in the total mixed diet of the population during 1962 was about 10 pC/g, 60% above the 1961 average and 10% above 1959. In the second half of 1962, the mean $^{90}Sr$ content of 76 bone samples from newborn infants examined at Woolwich and Glasgow was 1.37 pC/g Ca. The previous highest mean was 1.14 in July-December, 1959; and in the corresponding half of 1961 the mean of the samples was 0.87. For children aged between 14 days and one year, the highest single figure among the 1962 samples was 5.2 pC/g. These increases in bone Sr do not bring the levels up to the MRC cautionary figure of 33.5 pC/g, but it is likely that the Sr content of bone will rise further as the dietary increases of 1962-63 take effect. (BBB)

**22254** STRONTIUM-90 IN FINNISH MILK DURING 1960-63. O. Paakkola (Inst. of Radiation Physics, Helsinki). Nature, 202: 349-50(Apr. 25, 1964).

Milk samples were collected from sites in Finland producing about 21 percent of the country's milk. Monthly samples from each site were obtained by bulking aliquots. On one area liquid milk was collected twice a week for analysis. Samples were analyzed for $^{90}Sr$ during 1960-63. Results show that the spring maximum in Finnish milk is low compared with results from the United Kingdom, Germany, and the United States. Influence of pasteuring practices and rainfall on milk $^{90}Sr$ content are considered. (H.M.G.)

**22255** CORRELATION BETWEEN THE CONCENTRATIONS OF LEAD-210 (RADIUM D) AND CESIUM-137 IN GLACIER ICE. Zbigniew Jaworowski. Nukleonika, 8: 853-5(1963).

The results of determinations of the lead-210 and cesium-137 contents in water samples from the corrie glacier in the Polish part of Tatra Mountains are presented. (P.C.H.)

**22256** DEPOSITION OF Sr-90 AND Cs-137 IN TOKYO THROUGH THE END OF JULY 1963. Y. Miyake, K. Saruhashi, Y. Katsuragi, T. Kanazawa, and S. Tsunogai (Meteorological Research Inst., Tokyo). Papers Meteorol. Geophys. (Tokyo), 14: 58-65(Nov. 1963). (A/AC.82/G/L.922)

Integrated amounts of deposition of $^{90}Sr$ and $^{137}Cs$ through the end of July 1963 are respectively 45.2 $mC/km^2$ and 125.4 $mC/km^2$ taking the radioactive decay into consideration. From the observation of $^{90}Sr$ deposition during the one-yr period since September 1961, it was concluded that the ratio of fission and fusion energy of the explosion which took place in the fall of 1961 would be 1:5 and the total release of $^{90}Sr$ would be about 2 MC. The residence time of nuclear debris in the stratosphere was newly calculated and the residence time of one yr was given as its minimum value. Comparisons were made between the calculated values of $^{90}Sr$ from total beta counting data and the observed values by radiochemical analysis. The results showed good agreement during the period from November 1961 to May 1962. The analysis was done with respect to the relation between meteorological conditions and fallout rate and the increase of fallout was observed when the trough at 500 mb existed above the observation site. The analytical data of radionuclides in rain water collected on October 26-27, 1961 and radioiodine data in the air of Tokyo from September to December 1961 are listed. (auth)

**22257** RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME V, NUMBER 4. (Public Health Service, Washington, D. C.). Apr. 1964. 45p. $0.50(GPO). (RHD-Vol.5, No. 4)

Studies on fallout in air, milk, food, and water are reviewed. Data tabulations are included where feasible. A separate abstract was prepared for one section. (H.M.G.)

*For abstract of an individual section see: 22258.*

**22258** STRONTIUM-90 DEPOSITION ON THE EARTH'S SURFACE, 1962. William R. Collins, Jr. (U. S. Atomic Energy Commission, Washington, D. C.). Radiol. Health Data, 5: 163-5(Apr. 1964).

Quarterly $^{90}Sr$ deposition figures by latitude bands, based on the world-wide pot and resin column collections made by the Health and Safety Laboratory are presented for 1962 along with a review of previous data for comparison. Locations of sampling sites are mapped. From the data it was estimated that 1.49 MC of $^{90}Sr$ were deposited on the earth's surface during 1962. Average $^{90}Sr$ fallout by 10° bands of latitude and estimates of total $^{90}Sr$ deposition by hemisphere and quarter are tabulated. (H.M.G.)

**22259** A STUDY ON THE RADIOACTIVITY LEVEL OF THE ATMOSPHERIC AIR IN WARSAW. Konrad Kosinski and Zbigniew Misiakiewicz. Roczniki Panstwowego Zakladu Hig., 15: 59-66(1964). (In Polish)

A method for determination of total $\beta$ radioactivity of the inorganic matter of aerosols (>0.1 $\mu$ in dia) is described. The method involves paper filters and an apparatus. In the study, the samples of air amounted to 400 $m^3$/5 hr. During the first eight months of 1961 in Warsaw the $\beta$ radioactivity of the aerosol averaged $2.22 \cdot 10^{-12}$ C/$m^3$, while during the rest of the year it increased to $36.75 \cdot 10^{-12}$ C/$m^3$. (auth)

## Site Survey and Selection

**22260** (TEI-841) GEOLOGY OF THE PLUTO SITE, AREA 401, NEVADA TEST SITE, NYE COUNTY, NEVADA. Ross B. Johnson and John R. Ege (Geological Survey, Washington, D. C.). Apr. 1964. 146p.

Geologic studies by the U. S. Geological Survey in support of the U. S. Air Force's Project Pluto in Area 401 of the Nevada Test Site were made on behalf of the U. S. Atomic Energy Commission. The Survey was requested to make a detailed geologic investigation of the area and to provide basic geologic data for the use in the design, construction, and testing of a pilot underground air-storage chamber for the Pluto nuclear-powered ram-jet. Area 401 is in the south-central part of the U. S. Atomic Energy Commission's Nevada Test Site and consists of about 9.6 square miles including Wahmonie Flat. The area is approximately 12 miles northwest of Mercury, Nev. It does not have officially delimited boundaries. Geographically, the area generally is bounded on the southwest by the low drainage divide between Wahmonie Flat and Jackass Flats, on the northwest by the southeastern slopes of Lookout Peak, on the north and northeast by small rugged hills that are unnamed, and on the south by the northern slopes of Skull Mountain. The area of principal interest consists of about three square miles in the northeast corner of Area 401. In order to provide an adequate geologic background, particularly in structure, petrography, and geologic history, Area 401 was mapped in detail at a scale of 1:12,000. Two prospective chamber sites were mapped by planetable and telescopic alidade to delineate smaller structural features. These were compiled on topographic base maps, scale of 1:600. The maps were reduced photographically to a scale of 1:1,200 for publication. To obtain a more accurate 3-dimensional picture of the geology and to investigate ground-water conditions, five exploratory test holes were cored to depths ranging from 111 to 778 ft. Gravity, seismic, and resistivity surveys were made of the area to supplement geologic studies by providing subsurface information on the bulk physical properties of the rock, changes in rock types, variation in water content, and major structural features. (auth)

## Techniques and Equipment

**22261** (AD-434785) PROJECT SHOAL—VOLUNTEER TEAM PROGRAM. Technical Report No. 64-26. R. A. Weisbrich (Geotechnical Corp., Garland, Tex.). Mar. 23, 1964. Contract AF33(657)-12145. 39p.

The Volunteer Team Program was originated to give oil companies and their geophysicists an opportunity to participate in the VELA research program. They were joined in this endeavor by universities, research organizations, and independent scientists. Twenty-four volunteer teams joined in monitoring SHOAL. Sixteen teams succeeded in recording seismic energy from the explosion. The objectives of the VELA Program and the VELA-UNIFORM portion under which seismic energy from underground nuclear explosions is studied are described. Preparations made to facilitate monitoring SHOAL are discussed and the results obtained by the Volunteer Teams monitoring this test shot are summarized. (auth)

**22262** (JPRS-24435(p.46-63)) RECENT DATA ON THE DETERMINATION OF THE ABSOLUTE AGE OF THE EARTH. V. I. Baranov. Translated from Vopr. Kosmogonii, Akad. Nauk SSSR, 6: (July 19, 1958). 18p.

The results of determinations of the absolute age of minerals, meteorites, and chemical elements, made by radioactive methods, which enable one to estimate the absolute age of the Earth are presented. The age of the Earth lies between the limits of $3 \times 10^9$ years—the figure for the most ancient minerals—and $(5-6) \times 10^9$ years—the figure for chemical elements; the age of the Earth's crust is placed at $(4-5) \times 10^9$ years. (auth)

**22263** PROBLEMS IN NUCLEAR GEOPHYSICS AT THE CATHEDRAL OF PHYSICS II AGH, INSTITUTE OF NUCLEAR TECHNOLOGY AGH, AND THE KRAKOW DIVISION VI OF THE INSTITUTE OF NUCLEAR RESEARCH. Leopold Jurkiewicz (Inst. of Nuclear Physics, Gorniczo-Hutniczej Academy, Krakow and Inst. of Nuclear Research, Krakow). Postepy Fiz., 14: 649-58(1963). (In Polish)

The role of nuclear spectroscopy is discussed in the context of the overall problem of oil-well-logging problems, core-drilling analysis, and prospecting. The discussion of nuclear geophysics, its methods and problem areas, is presented in terms of broad areas of technique. These include logging by detection of natural radioactivity in the layers, gamma-gamma logging, and neutron-neutron logging, and neutron-gamma logging. The intensity of natural radioactivity and the spectrum of gamma rays not only gives direct evidence of potassium salts and of uranium and thorium content, but also gives more general information of the composition of earth strata. Some compositions are characterized by a very low level of radioactivity. The gamma-gamma logging, which measures the spectrum and intensity of transmitted and reflected gamma rays, gives a measure of density and atomic weight of the constituents of the strata. Neutron-neutron and neutron-gamma logging measure the reflected neutrons and gammas respectively. The measurement of both fast and moderated neutrons, and of neutron-produced gammas is treated for both a steady-state neutron source and a pulsed source. The latter source makes it possible to detect separately either fast or slow neutrons and either neutron-inelastic-scattered gammas, neutron-capture gammas, or neutron-induced-gamma radioactivity. (TTT)

**22264** METHOD OF RADIOLOGICAL WELL LOGGING USING A RADIOACTIVE TRACER WITH A CARRIER.

Henry A. Bourne, Jr., Earl W. Sutton, Francis R. Conley, and James C. Albright (to Continental Oil Co.). U. S. Patent 3,129,331. Apr. 14, 1964. Filed Sept. 26, 1960.

A method for locating and identifying fluid-producing formations of a subterranean reservoir traversed by a well bore involves the making of three or more logs by passing a radiation detection means through the well bore. The initial log records the natural radioactivity of the formations. The second log is made after the introduction of a radioactive material in a suitable carrier and its dispersion into adjacent formations by pressure. The well is then returned to normal production and, when the fluids produced become substantially free of radioactive material, a third log is made. Other logs may be made if desired while producing the well. Comparison of the logs indicates the permeability of the formations and the nature of the fluid produced from each. (A.G.W.)

## Thorium and Uranium Minerals

**22265** HIGH-GRADE URANIUM ORE BODY NEWLY DISCOVERED AT NINGYÔ-TÔGÉ. Fumio Tōgō and Hiroshi Takase (Atomic Fuel Corp., Tokyo). Nippon Genshiryoku Gakkaishi, 6: 37-44(Jan. 1964). (In Japanese)

The result of uranium prospecting for economic development since 1963 has shown that Ningyô-tôgé and its vicinity on the boundary of Okayama and Tottori Pref., the region composed of Misasa Group of Neogene Teritary, have the industrial possibilities from the viewpoint of their grade and ore reserves. Ten uranium ore bodies or so were already found and their ore reserves were also grasped (or reserves of each body: less than several hundreds thousand tons, their average grade: about 0.06% $U_3O_8$). It is said that this average grade is lower than those of foreign countries. Recently, the continuous distribution of high-grade uranium ore body over 8000 $m^3$ was discovered in the south gallery of Nakatsugo, Ningyô-tôgé mine where the intensive prospect by tunnelling had been put under way. It was confirmed that its average grade is 1%, the thickness of the mineralized layer is 0.65 m and the amount of uranium metal is more than 100 t. An outline of the significant ore body is presented. (auth)

**22266** DIE LAGERSTÄTTEN DES URANS. (The Deposition of Uranium). Albert Maucher. Brunswick. Friedr. Vieweg and Sohn, 1962. 169p. DM 22,--.

The geology of uranium minerals is discussed. Topics covered include: Clark number; definition of the concept of deposits; geochemistry of uranium; special geochemical distribution of uranium; rock solidification; uranium in the shell structure of the earth's crust; sandstone conglomerated, coal, phosphorite, and black-slate ores; endogenic stones as uranium deposits; hydrothermal ganglionic deposits; and uranium reserves. (M.C.G.)

**22267** EFFECT OF WEATHERING ON RADIOACTIVE ELEMENTS IN THE CONWAY GRANITE OF NEW HAMPSHIRE. K. A. Richardson and J. A. S. Adams. 10p. (CONF-498-3)

From Geological Society of America 1963 Annual Meeting, New York, Nov. 1963.

Studies were made on the effects of weathering on thorium and uranium in the Conway granite of New Hampshire. The results showed that weathering processes have leached and isotopically fractionated uranium to a depth of 30 to 40 ft below the surface, and leaching of uranium has occurred at greater depths in the vicinity of joints. This chemical alteration has occurred in rock that does not optically show evidence of weathering. (P.C.H.)

# HEALTH AND SAFETY

*Refer also to abstracts 21780, 22246, 22252, 22253, and 23139.*

**22268** (AD-417502) CRITICAL INDUSTRY REPAIR ANALYSIS. ELECTRIC POWER. Final Report. Randle H. Powley, ed. and Olaf H. Fernald (Advance Research, Inc., Cleveland). [1962]. Contract OCD-OS-62-257. 235p.

In general, vulnerability studies of electric power plants indicated that the critical blast-damage levels for the hydroelectric facilities would be higher than those for the steam plant. Similarly, fallout hazards would be less serious at the hydroelectric plant than at the steam plant. Thermal radiation was not a major structural factor at any of the plants under consideration. The plant studies agreed that production at most facilities would be interrupted by flying glass at blast overpressures within the range of 0.1 to 1.0 psi. (auth)

**22269** (AD-419518) CRITICAL INDUSTRY REPAIR ANALYSIS: STEEL. Final Report. Olaf H. Fernald and Randle H. Powley, ed. (Advance Research, Inc., Cleveland and Hoff Research and Development Labs., Inc., Cleveland). [nd]. Contract OCD-OS-62-257. 249p.

A comprehensive analysis was made of the relation of the processing environment and vulnerability of representative raw-material and iron/steel-producing facilities in a critical steel complex to repair and recovery from the effects of thermonuclear attacks. The scope includes special attention to salient bottlenecks in the operation and flow of the process from basic raw materials through finished production. Significant potential damage, general repair considerations, and production operations were studied at a large steel complex on the Ohio River in western Pennsylvania; raw materials were studied at the installations of some suppliers of this plant. The processing of the three primary raw materials, coal, ore, and limestone, was treated both as part of the complex and as a separate entity from the standpoint of potential damage. (auth)

**22270** (CLOR-19) PERSONNEL FILM MONITORING SERVICE IN POLAND DURING THE YEARS 1961–62. T. Musialowicz and J. Wysopolski (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). 1963. 25p.

Results of a systematic monitoring program in isotope laboratories in Poland showed a decrease in the number of persons with exposure doses exceeding 5 rem/yr from 1.4% in 1961 to 1.1% in 1962. Exposure determinations were made for 2351 employees of 79 establishments in 1961 and for 2712 employees of 92 establishments in 1962. Doses above 5 rem/yr occurred in women working with Ra applicators. (C.H.)

**22271** (COO-277) FIRE TEST OF WOODEN-JACKET SHIELD FOR RADIOISOTOPE SHIPPING CONTAINER. Leonard H. Horn (Underwriters' Labs., Inc., Chicago). Mar. 23, 1964. Contract AT(11-1)-1022. 41p.

A standard 1-hr fire test was conducted upon a design sample of a wooden-jacket shield for radioisotope shipping containers under controlled conditions equivalent to similar tests upon safes and record-protection cabinets that may be exposed to fires in buildings, warehouses, and comparable structures. The sample was partially filled with approximately 2600 lb of lead bricks and subjected to a 30-ft drop test prior to the fire test. The fire test exposure was limited to 1 hr maximum time and furnace gas fuel was controlled to produce furnace temperatures in accordance with the Standard Time-Temperature Curve adopted by United States fire protection authorities, also as set forth in proposed Part 72 of Title 10 Federal Regulations. The standard 1-hr fire, mentioned in the proposed Regulation, is described as one in which the following temperatures are attained in the test furnace: 1000°F after 5 min; 1300°F after 10 min; 1550°F after 30 min; 1700°F after 1 hr. The maximum temperature measured within the shield was 210°F at the end of the 1-hr test period. Immediately following the fire test, the sample was subjected to a standard 1-min hose stream test. The shield successfully withstood the tests without collapse and without subjecting the enclosed lead bricks to temperatures exceeding their melting point. (auth)

**22272** (CRRD-1137) A NEW PHOTOBADGE AT THE CHALK RIVER NUCLEAR LABORATORIES. G. B. Knight, S. D. Simpson, W. G. Cross, and G. Cower (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1963. 38p. (AECL-1900)

A new photographic film badge to record cumulative exposures of personnel to radiation was introduced at the Chalk River Nuclear Laboratories in December 1962. A general description of the badge is given and the radiation characteristics, dosimetry techniques, and operational experience are discussed. A comparison is made with the performance of the model it has replaced. (C.H.)

**22273** (HW-68274) STRONTIUM-90 SHIPPING CASK AND PROTECTIVE BUFFER. W. R. Kendall and D. W. McLenegan (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 14, 1961. Contract AT (45-1)-1350. 22p.

Equipment designed for transporting high-energy radioactive material, particularly $^{90}Sr$, by railroad over long distances is described. Design permits use of routes representing variations of topography and climate. Diagrams and specifications are presented for a shielded cask and the cask buffer. (H.M.G.)

**22274** (N64-13168) THE DECEMBER 1962 REPORT OF THE RBE COMMITTEE TO THE ICRP AND ICRU IN ITS IMPLICATIONS FOR THE ASSESSMENT OF PROTON RADIATION EXPOSURE IN SPACE. Report No. 26. Hermann J. Schaefer (Naval School of Aviation Medicine, Pensacola, Fla.). Oct. 18, 1963. 15p.

Some of the implications of new rules set forth concerning exposure to proton radiations in space are discussed. The proposed formulas assigning precise values of relative biological effectiveness (RBE) and quality factor (QF) to any given linear energy transfer (LET) are evaluated for typical spectra of x rays, flare-produced protons, and neutron recoil protons. The results essentially reconfirm earlier assessments. Since the report reemphasizes the basic difference between low LET and high LET radiation with regard to residual damage from low dose rate exposures, it seems advisable that dosimetric instrumentation for manned space operations provides ways and means for separate measurement of the two fractions of exposures to proton beams. (auth)

**22275** (NP-13885) RADIOLOGICAL MONITORING FOR CIVIL DEFENSE. (Edgerton, Germeshausen and

Grier, Inc., Santa Barbara, Calif.). Aug. 13, 1963. 127p. (S-235-R)

Radiological monitoring and fallout prediction concepts of the present civil defense program are presented, and recommendations are made for improving the program. The conclusions and recommendations result from a detailed study of the radiological information needs and various radiological monitoring methods. This study included instrumentation and equipment, small scale perturbations of the radiation field by various factors, and fallout prediction methods. The recommendations made include using aerial monitoring techniques as the primary radiological monitoring method and considering the use of a fixed automatic system at the national level only. Other specific recommendations involve instrumentation, training, and organization. (auth)

**22276** (ORNL-3591(p.167-74)) FISSION PRODUCTS RELEASED BY NONNUCLEAR HEATING OF FUEL MATERIALS. G. W. Parker, W. J. Martin, G. E. Creek, R. A. Lorenz, and C. J. Barton (Oak Ridge National Lab., Tenn.).

An investigation of the effect of burnup on the release of fission products from aluminum–uranium alloy fuel material in laboratory-scale apparatus showed that the release of iodine and rare gases was much higher from specimens irradiated to 3.2% burnup than from trace-level-irradiated material. Little change in release with increasing irradiation in the range 3.2 to 23.6% burnup was noted, except for cesium, which was released to a greater extent at the highest burnup level. Emphasis in research designed to assess the hazards of loss-of-coolant reactor accidents is on the behavior of released fission products, but information on amounts of fission products released from overheated fuels is still being obtained. A recently completed hot-cell facility permitted both types of studies, in addition to tests of a proposed reactor confinement filter system. The distribution of fission products from irradiated aluminum–uranium alloy and clad $UO_2$ fuel specimens melted in controlled atmospheres was observed, and diffusion tubes were employed to study the effect of filters and other materials on the distribution of activity associated with small particles or in the vapor form. Iodine released from molten aluminum–uranium alloy fuel was found to deposit much faster on a dry stainless steel surface than on the same material saturated with steam, while the reverse behavior was exhibited by cesium. These observations indicated that cesium iodide was not an important component of the aerosol formed under test conditions. The small amount of condensate recovered in the moist-air experiment contained only about 6% of the released iodine and cesium. When trace-level-irradiated, stainless-steel-clad $UO_2$ fuel was melted, a relatively large fraction of the released iodine (35%) and of the tellurium (49%) was found to remain airborne in the dry-air atmosphere of the aerosol tank after an aging period of approximately 1.5 hr. A surprisingly large fraction of the released iodine (19%) was caught on the roughing filter, possibly because of the very low iodine concentrations in the aerosol, and the iodine, which passed through the filters, was poorly retained on bronze screens and in charcoal traps, indicating that a part of the iodine was not in the molecular form. Particle-size studies were performed by collecting particles on a specially prepared grid of an electrostatic precipitator, on filters, and on the walls of diffusion tubes. Particles remaining in the aerosol after the aging period in the aluminum–uranium alloy melting experiments ranged in size from about 0.015 to 3 $\mu$. About 95% of the iodine reaching the filters, representing 17% of the iodine originally in the fuel, was found to be in the molecular form, according to its deposition rate in the diffusion tube; the other 5%, representing 1.0% of the fuel inventory, was associated with particles about 26 Å in diameter. No evidence of the presence of cesium iodide in the aerosol was found in the diffusion tube data. Particles produced on melting stainless-steel-clad $UO_2$ ranged from about 0.01 to 2 $\mu$ in diameter; some of the larger particles that were shaped like wafers were identified as FeO. Diffusion tube data indicated a more complicated particle spectrum in the aged aerosol reaching the filters than was observed in the aluminum–uranium alloy experiments. Iodine was associated with particles of 12 (molecular), 24, and 108 Å in diameter, carrying approximately 80, 15, and 5%, respectively, of the airborne iodine. Unclad miniature $UO_2$ fuel pins, arranged in a seven-pin cluster with the center pin irradiated at the tracer level, were melted in purified helium by use of tungsten resistance rods in order to simulate nuclear heating (center of the fuel hotter than the outside) and reactor core melting conditions with the outside fuel rods cooler than those in the center. Two experiments of this type showed that the release of fission products from these arrangements was approximately one-half that found in previously reported tests, where single unclad $UO_2$ fuel pins were melted. The third assembly that used the seven-pin cluster arrangement was constructed so that the helium sweep gas traversed a path providing longer and closer contact with the shields and base plate before leaving the furnace. The amount of volatile fission products transported to the filter in this experiment was less by a factor of 10 than in the other two cluster experiments, where a direct gas path was available. (auth)

**22277** (ORNL-3591(p.182-4)) RELEASE OF FISSION PRODUCTS DURING MELTING OF FUELS UNDER TRANSIENT REACTOR CONDITIONS. G. W. Parker, R. A. Lorenz, and C. E. Miller, Jr. (Oak Ridge National Lab., Tenn.).

Two experiments performed in the TREAT reactor simulated accidents that could occur during the startup of a new reactor, where the only fission products available for release are those due to fissions that occur during a very short period just prior to fuel failure. Reactor periods of 108 and 87 msec, with integrated reactor power of 320 and 328 Mwsec, respectively, were used in these experiments. In the first experiment, the stainless steel cladding melted and the $UO_2$ temperature rose above 2600°C, but the sample did not melt. The outside diameter of the pellets increased 2%. Approximately 65% of the $UO_2$ specimen melted in the second experiment, the outer diameter of the unmelted portion of the specimen increased 18%, and 10% of the $UO_2$ flowed out of the unmelted pellet shell. Meaningful samples of the released aerosols were collected, and particle-size distributions were obtained. Fission product release under the conditions of these experiments was shown to be related to the physical characteristics of precursor species present while the fuel was at or near its maximum temperature. Furthermore, it was determined that the release from the high-temperature zone was less than 2% for isotopes that did not have volatile precursors. (auth)

**22278** (ORNL-TM-630) ISOTOPES DEVELOPMENT CENTER SAFETY TESTING PROGRAM. Progress Report, March–April 1963. R. A. Robinson, comp. (Oak Ridge National Lab., Tenn.). Sept. 24, 1963. Contract W-7405-eng-26. 28p.

Testing on radiation sources and casks was continued to provide information that will assist in maintaining safety

in packaging and shipping radioactive materials. Results of tests on cask fire and impact shields constructed of wood show that ~3½-in.-thick maple shields will adequately protect a cask weighing up to 234 lb from damage when subjected to a 30-ft free fall onto a 6-in.-diam piston or onto one of its corners and the standard 1-hr fire test. Tests to determine the effects of aging were conducted on a 9-yr-old $^{137}$CsCl source containing 1540 C and showed no evidence of corrosion or radiation damage. The $^{239}$Pu and $^{241}$Am α calibration sources that were held for a total of 120 days and subjected to tests at the end of each 30 days were retested to determine aging effects. The $^{238}$U α calibration sources that were held for 90 days were also retested. These tests have not yet shown any conclusive change in the percentage of transferable activity as the sources aged. New $^{241}$Am α calibration sources exhibited losses of up to 0.025% in smear tests at moderate finger pressure. This value represented 0.025 μC $^{241}$Am, a factor of 5 times the allowable smear loss for an α source. In all tests the new uranium α calibration sources were within the 0.005 μC loss tolerance. Elevated temperature, leaching, and mechanical tests were performed on foil-type $^{241}$Am and $^{210}$Po sources, and specimens were stored for future aging effects tests. (auth)

**22279** (URS-638-2) STUDY OF FACTORS INFLUENCING REMEDIAL MOVEMENT. Myron B. Hawkins (United Research Services, Inc., Burlingame, Calif.). Apr. 17, 1964. Contract OCD-PS-64-20. 26p.

The feasibility of remedial movement, transfer of people from inadequate fallout shelters to areas providing greater protection, was investigated. The study took into account fallout arrival time, reference radiation intensity, shelter or refuge protective factor, and travel time. Primary payoff conditions were defined in terms of reduction of radiation casualties. Within the limitations imposed by the conditions of the study, certain general conclusions were: maximum opportunities for payoff are related to refuges having lower protection factors (less than 10); maximum payoff conditions are related to fallout arriving at early times; maximum payoff conditions generally involve reference radiation intensities of 350 r/hr or greater, with the upper limit of about 2000 r/hr; and for one-hour arrivals (i.e., when fallout arrives at about one hr after detonation), the maximum allowable travel time for maximum payoff is about 1.3 hr. (auth)

**22280** (Y-1460) A NUCLEARLY SAFE CONTAINER FOR CLASS II SHIPMENTS OF DRY URANIUM COMPOUNDS. W. T. Mee and F. G. Welfare (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Nov. 26, 1963. Contract W-7405-eng-26. 17p.

A simple and inexpensive container was evaluated for use in Class II commercial shipments of dry, enriched uranium materials. Physical test results and nuclear safety determinations associated with the transportation of the containers were compared to the criteria in proposed regulations on transportation by the International Atomic Energy Agency and the US Atomic Energy Commission. It was concluded that the container meets the requirements for Class II shipments of $^{235}$U with restrictions on the type, form, and quantity of materials to be shipped. Specifically, it is shown that 40 containers, each loaded to a maximum of 20 kilograms of uranium up to 94.0% $^{235}$U as dry compounds or metal, in an inner container of four liters volume or less, can be shipped according to the proposed requirements. (auth)

**22281** (NP-tr-1136) RADIOLOGICAL HYGIENE EVALUATION OF MILK AND MEAT FROM COWS AFFECTED BY RADIO-IODINE. V. G. Il'in. Translated by J. B. Sykes (U.K.A.E.A. Research Group. Harwell, Berks, Eng.), from Veterinariya, 8: 69-70(1961). 6p. (Handwritten MS Copy).

When $^{131}$I was administered to cows in fodder in doses of 5 to 6 μC/kg, the milk and meat exceed the maximum permissible radioactivity for more than three weeks after ingestion. When the animals were slaughtered 23 days after ingestion, the thyroid gland contained 87% of the total activity in the body. It must therefore be rejected and destroyed. The largest amount of $^{131}$I was excreted with the milk in the first four days after ingestion. About 89 to 90% of the total activity was excreted in milk during 18 days. The acceptance for food of meat and milk from cows that have ingested $^{131}$I must be preceded by radiometric examination. Where contamination exceeds the maximum permissible level, the meat must be stored in a refrigerator and the milk made into products that are stored for periods of time long enough for the activity to decrease by natural decay of $^{131}$I. (C.H.)

**22282** HAZARDS OF DIAGNOSTIC RADIOLOGY IN PEDIATRICS: RISK VERSUS BENEFIT. John A. Evans (Cornell Univ., New York). Am. J. Surg., 107: 400-5(Mar. 1964).

An evaluation is made of the usual dosages in pediatric x-ray examinations and of protective techniques. Ways in which diagnostic x-ray exposures can be reduced are enumerated. (BBB)

**22283** RADIATION EXPOSURE. Francis Le Tard and Charles D. Belleau (Ochsner Foundation Hospital, New Orleans). Anesthesiology, 23: 267-8(Mar.-Apr. 1962).

The amount of radiation to which an anesthesiologist is exposed during a period of one year was measured. Film badges were worn constantly by six anesthesiologists on the breast pocket of their scrub suits for one year. No lead apron or other protective device was employed during this time. Additional, separate badges were worn for each of the following procedures: pneumoencephalography and ventriculography, cystography, bronchography, angiography, hip nailing, and cholangiography. The badges were analyzed periodically. During the year, 268 procedures necessitated the combined use of roentgenography and anesthesia. None of these procedures was associated with fluoroscopy. The total amount of radiation received by each of the six badges for the year varied from 150 to 245 mr. The average dose was 3.7 mr/week. The average radiation dose for each badge per case was for pneumoencephalography and ventriculography 5, cystography 18, bronchography 20, angiography 25, hip nailing 25, and cholangiography 25 mr. During film exposure to ionizing radiation, the anesthesiologist sought the greatest distance from the x-ray tube while remaining near enough to the patient to maintain safe anesthesia. Metal cones were used on all equipment to minimize radiation scatter. Use of high-speed film also reduced the amount of radiation by requiring less exposure time per film. It is suggested that the use of proper equipment that has been recently tested, proper technique using low milliamperage and high kilovoltage, use of fast screen casettes, and avoidance of fluoroscopy, when a film will serve the same purpose, are all basic safety measures that will reduce the amount of exposure to ionizing radiation during roentgenographic procedures. It is believed that the amount of radiation measured here is probably similar to that in other centers whose radiologists and anesthesiologists are aware of the dangers of exposure to radiation. (BBB)

**22284** PUBLIC HEALTH ASPECTS OF RADIOACTIVE CONTAMINATION UNDER NORMAL CONDITIONS

AND EMERGENCIES. Alfredo Spena. Ann. Med. Navale (Rome), 67: 621-38(Sept.-Oct. 1962). (In Italian)

**22285** PUBLIC HEALTH ASPECTS OF RADIOACTIVE CONTAMINATION UNDER NORMAL CONDITIONS AND EMERGENCIES. Alfredo Spena. Ann. Med. Navale (Rome), 67: 741-56(Nov.-Dec. 1962). (In Italian)

**22286** HEALTH ASPECTS OF RADIOACTIVE CONTAMINATION UNDER NORMAL AND EMERGENCY CONDITIONS. Alfredo Spena. Ann. Med. Navale (Rome), 68: 27-46(Jan.-Feb. 1963). (In Italian)

**22287** PROBLEM OF SUPERVISION OF RADIOACTIVE MATERIAL IN WATER FROM THE FIRST RADIATION PROTECTION REGULATION. Klaus Haberer (Technische Hochschule, Karlsruhe, Ger.). Gas Wasserfach, 102: 766-71(July 1961). (In German)

Regulations that the total radioactivity of water not exceed $10^{-7}$ $\mu C/cm^3$ and limits for certain "dangerous" radioisotopes are discussed. The problems of control to meet these regulations are described. (M.C.G.)

**22288** DISASTER PLANNING FOR THE HOSPITAL ENGINEER. Charles W. Barton (Veterans Administration Center, Los Angeles). Hospitals, 36: 61-9(Oct. 16, 1962).

Civil defense planning for hospital maintenance is reviewed, especially with regard to continuation, during an attack, of water distribution, sewage facilities, and electric supply for emergency power, light, and refrigeration. (BBB)

**22289** EVALUATION OF ORNL CARDBOARD-BOX-STEEL-CAN SHIPPING CONTAINER. Karl W. Haff (Oak Ridge National Lab., Tenn.). Isotopes Radiation Technol., 1: No. 3(1964).

Cardboard-box-steel-can containers for use in shipping radioisotopes were tested to determine whether the containers meet present IAEA specifications and to evaluate the suggested tests. Results indicate that the containers are adequate to meet requirements. (C.H.)

**22290** RADIOACTIVE WASTES. Lancet, 2: 1285 (Dec. 14, 1963).

A brief report of a parliamentary debate concerning the potential hazards and the level of contamination caused by release by hospitals of radioactive materials into sewage, especially radioiodine and $^{224}Ra$. (BBB)

**22291** EFFECTS OF RADIATION. L. A. Whitehill. Lancet, 2: 1384(Dec. 28, 1963).

Permissible levels of occupational radiation exposure are discussed briefly in relation to background levels. (BBB)

**22292** DISCUSSION OF PAPER ON DECAY PRODUCTS OF RADIUM IN CERAMICS AND THEIR INTERACTION WITH MATTER. Mater. Res. Std., 4: 220-1(May 1964).

**22293** GENERAL EFFECTS OF NUCLEAR EXPLOSIONS. Jose Amaro Lasheras (Instituto de Higiene Militar, Madrid). Medicina (Madrid), 29: 523-48(Nov. 1961). (In Spanish)

The types of human injuries that might be encountered in a thermonuclear war are discussed. (BBB)

**22294** NATIONAL SHELTER PROGRAM AND ITS MEDICAL ASPECTS. Paul S. Visher (Department of Defense, Washington, D. C.). N. Y. State J. Med., 63: 3294-7(Nov. 15, 1963).

Various aspects of development of a fallout shelter system in the United States are discussed. It is estimated that it should be possible to save 60 million people in a population attack and 120 million people in a counter-force attack. These people would be in shelters having a protective factor of 100 or better. In the country today are located nearly 60 million spaces that have a protective factor of 100 or more. There are 20 million additional spaces that have a protective factor of between 70 and 100, 40 million additional spaces that have a protective factor of between 40 and 70, and 80 million spaces that have a protective factor of between 20 and 40. The amount of shielding, space per person, ventilation, and food and water stocks for shelters is estimated. The kind of medical equipment and supplies to be placed in shelters is discussed. (BBB)

**22295** HANDLING PUBLIC CONCERN WITH HAZARDS OF RADIOACTIVE FALLOUT. Raymond T. Moore (Public Health Service, Washington, D. C.). N. Y. State J. Med., 63: 3578-81(Dec. 15, 1963).

The role of the Public Health Service (P.H.S.), and other government agencies, in monitoring and evaluating levels of fallout radionuclides is discussed. Numerous surveillance programs have been organized to measure the amounts of radioactive contaminants in surface water, precipitation, and in total diets. In cooperation with state health departments, sampling pasteurized milk is conducted in 60 cities, which represents the milk available for about $\frac{1}{3}$ of the total U. S. population. These samples are taken weekly and are analyzed for the more common nuclides of health significance. The P.H.S., through its various monitoring networks, makes information readily available to the state health departments and other responsible health agencies as the needs arise. At frequent intervals this same information is given to the public, to give an estimate of the hazards, if any, and to relate this to some standard that is well known to the public. The P.H.S. considers that public concern will best be handled when it is possible for all people to know what the hazard is, what is being done about it, and how soon and in what way they will be affected. Thus, to this environmental health problem are applied the same professional and public information policies that have been applied to the problems of communicable disease. It is concluded that undue public concern about radioactive fallout stems from lack of knowledge and that fear of peacetime fallout can be allayed by placing the problem in its proper perspective. The public information task involves explanation of the balance of benefits against risks, which may be long-term, including genetic ones. The importance of public agencies keeping physicians informed of radiation health data is also discussed. (BBB)

**22296** HOW TO WORK AND LIVE WITH RADIATION. Shields Warren (Harvard Medical School, Boston). N. Y. State J. Med., 64: 853-4(Apr. 1, 1964).

Attempts are made to assess the risks of increasing radiation exposure of man and the validity of available data on which such an evaluation can be made. If a linear effect down to zero dose is assumed, it may be concluded that among great numbers of people, small amounts of harm may have been done. The beneficial effects deriving from medical and other applications of radiation, which outweigh this harm, are discussed and radiation hazards are compared with other risks in modern life. (BBB)

**22297** SOMATIC EFFECTS OF RADIATION. Charles L. Dunham (Atomic Energy Commission, Washington, D. C.). N. Y. State J. Med., 64: 855-7(Apr. 1, 1964).

The possible hazards of environmental and man-made radiations to human somatic cells are discussed. It is proposed that statements to the effect that such and such a per cent of spontaneous mutations or of leukemias or of

bone cancers result from background radiation are made with little scientific basis and are speculation. The mutagenic action of radiation is also briefly discussed with reference to hazards to human populations. (BBB)

**22298** MAXIMAL PERMISSIBLE DOSE. Marshall Brucer. N. Y. State J. Med., 64: 857-61(Apr. 1, 1964).

The concept of the maximum permissible dose (MPD) of radiation is critically examined, and an attempt is made to apply this concept to other hazards of human life. An analogy of the application of MPD to the automobile accident death rate is presented in a factious way; this analysis of traffic deaths indicates a MPD for occupational drivers of 0.5 mi/hr. (BBB)

**22299** TRANSFER OF RADIO STRONTIUM FROM MILK TO CHEESE AND WHEY. T. J. Buma and J. Meerstra (Cooperative Condensfabriek "Friesland," Leeuwarden, Holland). Nature, 202: 310-11(Apr. 18, 1964).

Samples of raw milk, curd, whey, and cheese were taken during a period of relatively high strontium activity. All samples were ashed, and $^{89}Sr$ and $^{90}Sr$ separated by conventional radiochemical methods were counted by means of low-level $\beta$-counting equipment. In practice 10 kg of cheese is obtained from 100 kg of milk. Using the calcium contents of milk, cheese, and whey, the absolute strontium activities could be calculated. It was found for both isotopes that on the average about 80 per cent of the radioactive strontium present in the milk is transferred to the cheese and 20 per cent to the whey. As these percentages are equal to those found for the transfer of the proteins of the milk to the cheese and the whey, the ratio between radioactive strontium and protein seems to remain constant. (auth & H.M.G.)

**22300** STATE REGULATION OF RADIOACTIVE MATERIALS. John M. Heslep (California State Dept. of Public Health). Public Health Rept. (U. S.), 79: 308-12 (Apr. 1964).

Regulation of radioactive materials at the state level was instigated by Public Law 86-373 enacted by Congress in 1959. Justification of the assumption of responsibility by the state is based on the traditional role of the state in matters of health and safety, to which radiation may now be added. The narrow scope of radiation regulation is evaluated, and it is concluded that regulation should include all types of radioactivity. The establishment and function of the California regulatory body is discussed and evaluated. Problems arising from the AEC's relations with the Agreement States provided in the aforementioned law are considered. (H.M.G.)

**22301** SELECTING SURVEYORS OF X-RAY EQUIPMENT. Armand E. Brodeur (St. Louis Univ., Mo. and Glennon Hospital for Children, St. Louis, Mo.) and Edgar F. Seagle. Public Health Rept. (U. S.), 79: 317-23(Apr. 1964).

The St. Louis study demonstrated that for a relatively low cost an effective x-ray protection survey, from a public health significance standpoint, can be obtained by training and using health department personnel. In many areas they are the only persons available to perform such a survey. Even if sufficient certified radiation physicists and certified health physicists were available for survey purposes, they would be better engaged as consultants in matters such as calibration of therapy units and detailed and broad studies of x-ray installations or to design or supervise x-ray inspection programs, which can be carried out in a practical manner by personnel with less training and experience. Their function is obviously different from that of a surveyor whose sole function is to examine in a prescribed manner primarily for factors that contribute most to reduction of exposure from unnecessary radiation. The results of the study indicate that, from a cost and public health standpoint, the training of a health department person with a college degree by his own department or by the Public Health Service to perform effective x-ray surveys is a sound investment. This kind of x-ray surveyor has the potential for effecting the greatest mass reduction in unnecessary exposure to radiation in the United States today. (auth)

**22302** PROTECTION AGAINST I-131 IN UTAH. G. D. Carlyle Thompson, Grant S. Winn, and Lynn M. Thatcher (Utah State Dept. of Health). Public Health Rept. (U. S.), 79: 324-30(Apr. 1964).

Public health implications of radioactive fallout were stressed, and other aspects of the environmental radiation problem were touched on. Modern health departments, Federal, State, and local, need to incorporate in their program planning a recognition of this new and burgeoning problem. Taking on additional responsibilities and staff in a new field is admittedly difficult in view of the usual and well-recognized deficiencies in some programs of long standing, but no department can escape, in coming years, deep involvement in radiation matters. It will be wise to start preparing for such involvement now by a planned and orderly improvement of capabilities, including an adequate active surveillance program. The general principles underlying any successful program to control population exposures from environmental radioactive contamination are discussed. (auth)

**22303** X-RAY SURVEY PROGRAM IN MISSISSIPPI. Robert R. Rester (Mississippi State Board of Health, Jackson). Public Health Rept. (U. S.), 79: 331-2(Apr. 1964).

Initiation of a survey of x-ray equipment in Mississippi was focused on the dental profession. Dentists were chosen because their machines were simple and easy to inspect, the time required for inspection was much less than that for a medical diagnostic unit, the dental units were more concentrated, and experience was needed in personality interaction as well as machine inspection. Two surveys were made. Results of the first survey showed that 83% of the dental machines inspected did not meet the simple criteria established by the Mississippi State Board of Health. A second survey indicated that 85% of the dental machines and 70% of the medical units now meet state requirements. (H.M.G.)

**22304** NEW YORK'S RADIATION CONTROL SYSTEM. Sherwood Davies (New York State Dept. of Public Health, Albany). Public Health Rept. (U. S.), 79: 333-6(Apr. 1964).

The New York State Department of Health has established a routine radiological monitoring program. Samples of air, water, milk, and precipitation are collected and analyzed in its central laboratory. Stations are located throughout the State. Off-site air, water, and milk monitoring stations are established in cooperation with operators of nuclear facilities. A comprehensive environmental survey within 20 miles of the Indian Point nuclear power reactor, Brookhaven National Laboratory, and a chemical processing plant site provides data on the physical environment. This information is useful in evaluating possible impact of a nuclear reactor accident and establishing an adequate operational survey. (auth)

**22305** PROBLEMS IN RADIUM CONTROL. John C. Villforth. Public Health Rept. (U. S.), 79: 337-42(Apr. 1964).

Of all the more commonly used radionuclides, Ra has the longest and most dramatic history. Certain of its inherent characteristics make it a potential radiological health problem — its radiotoxicity, its series decay through alpha-, beta-, and gamma-emitting daughters including its first daughter product, Rn, which is a noble gas, its chemical and physical form, its ability to build up pressure in a sealed source, and its depreciation. These qualities and the fact that Ra was not systematically and generally under regulatory control contribute to its potential hazard. Radium continues to be used at approximately 4,500 facilities throughout the country, although cheaper, more adaptable AEC-licensed radionuclides are more readily available. Incidents and accidents are not uncommon, and contamination from leaking and ruptured sources has resulted in costly damage and required expensive decontamination. Most of these incidents could have been avoided by following accepted radiological health procedures. States are developing programs for the licensing, registration, and inspection of radium users, and the Public Health Service has established a program to assist the States in these activities. But the assistance of other agencies and professional groups is required to educate users to the potential hazards of improper handling and the use of antiquated sources and to investigate less hazardous substitutes for radium. (auth)

**22306** HEALTH AND SAFETY. Benito C. Bernardo (Philippine Atomic Research Center, Manila). Sci. Rev. (Manila), 4: 21-3(Sept. 1963).

Radiological health and safety precautions outlined by the Philippine Atomic Energy Commission for the research reactor, hospitals, and organizations using radioisotopes are briefly discussed. (C.E.S.)

**22307** PROTECTION OF THE ORGAN OF VISION FROM WAR INJURIES. Milan Kopsa, Kazimir Marusic, and Dragomir Panajotovic (Military Medicine Academy, Belgrade). Vojnosanit. Pregled., 20: 37-41(Jan.-Feb. 1963). (In Serbian)

Possible means of preventing eye injuries in nuclear war are discussed. (BBB)

**22308** RADIOACTIVITY IN MILK, 1963. Agricultural Research Council Radiobiological Lab., Report No. 11. London, Her Majesty's Stationery Office, 1964. 18p. 2s. 6d.

Levels of $^{90}Sr$ and $^{137}Cs$ in milk in the United Kingdom from April through December 1963, are given. The average $^{90}Sr/Ca$ ratio for 1963 was 26 pC/g, or about twice the 1962 level. The $^{137}Cs$ level for 1963 averaged 135 pC/l. No $^{131}I$ was detected in milk throughout this period. (BBB)

**22309** PERMISSIBLE LEVELS OF SURFACE CONTAMINATION. W. R. Bush (Atomic Energy of Canada Ltd., Chalk River, Ont.). 11p. (CONF-277-9)

From Symposium on Radiation Emergencies in Medicine, Research, and Industry, Chicago, Dec. 1963.

Surface contamination is undesirable because it gives rise to radiation hazards. Inhalation hazard is often the determining factor in setting contamination limits; however, external radiation could be a greater hazard under some circumstances. The relation between contamination level and radiation hazard is not precise, because of wide variations in practical conditions. Permissible levels of contamination are based on many arbitrary assumptions; when assessing dangerous levels of contamination, it would be better to recalculate permissible levels using the best information available for all parameters. Potentially dangerous areas should be identified with respect to the maximum degree of danger likely to be met in a contamination accident. (auth)

**22310** COLD WEATHER DECONTAMINATION. Joseph C. Maloney (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). 12p. (CONF-277-10)

From Symposium on Radiation Emergencies in Medicine, Research, and Industry, Chicago, Dec. 1963.

A series of cold weather radiological decontamination experiments utilizing radioactive particulate fallout simulant were conducted during the past several years at Camp McCoy, Wisconsin, under military and civil defense sponsorship. Methods and procedures of decontamination were tested to define the effects of cold weather and winter conditions on radiological reclamation of fixed installations. It was concluded that effective decontamination can be achieved by adjusting procedures and using new techniques applicable to cold conditions. (auth)

**22311** SAFETY CONSIDERATIONS IN INDUSTRIAL APPLICATIONS OF RADIOACTIVE SOURCES. John W. Kuhn (E. I. du Pont de Nemours and Co., Orange, Tex.). 18p. (CONF-110-5)

From American Institute of Chemical Engineers, 56th Annual Meeting, 1963 Annual Meeting, Houston, Tex., Dec. 1963.

The safety problem in handling radioactive materials is complicated by the fact that ionizing radiation is not detected by any of the five human senses. It is proposed that the application of radioactive sources be simplified so that their advantages can be obtained without compromising on safety. In fact, under optimum controls radioactive sources should be no more hazardous than commonly used industrial products and should be approached with the same respect given to corrosive acids, toxic gases, or electricity. (auth)

# INSTRUMENTATION

## General

**22312** (CERN-64-16) APPAREIL DE HAUTE PRECISION POUR LES MESURES DE DISTANCES. (Apparatus of High Precision for Measurements of Distances). J. Gervaise (European Organization for Nuclear Research, Geneva). Mar. 17, 1964. 33p.

An apparatus that permits distance measurements with a reproducibility of 0.01 mm is described. The apparatus is particularly suitable for measuring the alignment of accelerator magnets, engineering applications, and measurements of soil stability. (D.C.W.)

**22313** (IDO-16965) FUEL PLATE RESISTANCE THERMOMETER. R. H. Meservey (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Mar. 15, 1964. Contract AT(10-1)-205. 25p.

Details associated with the design and construction of a device that can be used to measure temperatures within reactor cores are given, along with reactor installation experiences. Three fuel plate resistance thermometers were fabricated and tested. Details of the testing and calibration curves are given for each resistance thermometer. The results from the installation of a fuel plate resistance thermometer in SPERT IV are given both in graphical and tabular form. Conclusions drawn from testing experiences are given along with suggestions for improvement, should future applications exist. (auth)

**22314** (ISS-63/9) TERMOSTATI PER COMPONENTI ELETTRONICHE. (Thermostats for Electronic Components). C. Felici and A. Rosati (Italy. Istituto Superiore di Sanità, Rome). Jan. 10, 1963. 15p.

A small thermostat designed to keep constant within a few hundredths of a degree the temperature of critical components of an electronic circuit is described. (auth)

**22315** (SLAC-26) DYNAMIC FIELD MEASUREMENTS WITH AN EMR MAGNETOMETER IN THE PULSED BEAM SWITCHING MAGNET. J. J. Muray and R. A. Scholl (Stanford Univ., Calif. Stanford Linear Accelerator Center). Feb. 1964. Contract AT(04-3)-400. 23p.

Amplitude jitter in the pulsed magnetic field was measured using EMR of the radical 1,1 diphenyl 2, picryl hydrazil. The magnetometer and measurements are described, and theory for the measurements and the helical probe used is given. Some results of measurements are displayed. (D.C.W.)

**22316** (TID-20537) MAGNETOMETER. Chris E. Kuyatt and Lowell H. Sohl (Nebraska. Univ., Lincoln). [1958]. Contract AT(11-1)-35. 27p.

A magnetometer for measuring small fields was required in an experiment involving low-energy electrons in zero magnetic field. Such a magnetometer was constructed using a single core excited at a frequency and a high-frequency Q meter to sense the core induction. The highest sensitivity of the magnetometer is 40 μa/milligauss, and magnetic field strengths can be measured to within 0.07 milligauss. The details of construction and operation of the magnetometer are described. (D.L.C.)

**22317** (UCRL-7730) A DYNAMIC METHOD FOR MERCURY VAPOR DETECTOR CALIBRATION. Gary O. Nelson, Walter Van Sandt, and Patrick Barry (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 21, 1964. Contract W-7405-eng-48. 26p. (CONF-496-2)

From American Industrial Hygiene Association Meeting, Philadelphia, Apr. 1964.

An apparatus was designed to facilitate the calibration of mercury vapor detectors. Known volumes of pure air, and air saturated with mercury, are mixed and introduced into a Lucite box that houses the meter under study. Calibration points are then obtained by adjusting the mercury vapor and air dilution ratios. Mercury concentrations are checked chemically by collecting the vapor in acidified potassium permanganate and analyzing by a dithizone extraction method. (auth)

**22318** CONVERSION OF PHOTOELECTRONS IN SECONDARY ELECTRON MULTIPLICATION. H. Graber (Zentralinstitut fur Kernphysik, Rossendorf, Ger.). Exptl. Tech. Physik, 12: 24-30(1964). (In German)

The sensitivity distribution on photocathodes of the secondary-electron-multiplier type was investigated by measurement of the pulse height with a small scintillator. A systematic place dependence of the electron yield, which was due to the form of the electron optical entrance system of the multiplier, was observed. The variation of the electron yield was dependent on the potential between the cathode and the electrode $E_1$. On the basis of measurements with NaI(Tl) crystals and organic scintillators it was shown how the resolution possibility and the pulse height are influenced by the focusing voltage of the controlling electrode $E_1$. (tr-auth)

**22319** A PULSE TRANSMITTER FOR CURRENT AND LIGHT PULSES IN THE NANOSECOND REGION. A. Eckardt, W. Dietel, and R. Prager (Friedrich-Schiller Universität, Jena, Ger.). Exptl. Tech. Physik, 12: 63-4 (1964). (In German)

A method for production of current and light pulses with a rise time smaller than $10^{-9}$ sec is described. The pulses were produced in a hydrogen-filled gas discharge tube. (M.C.G.)

**22320** KLYSTRONS WITH DOUBLE-GAP BUNCHERS. K. Chandra and M. R. Gavin (University Coll. of North Wales, Bangor, Wales). J. Electron. Control (1), 16: 65-77(Jan. 1964).

The use of double-gap bunching in klystrons is investigated theoretically and it is shown that under suitable conditions the beam coupling coefficient may be 40% higher than for a single gap. Also, the loading of the buncher by the beam under these conditions may be eliminated. It is estimated that the double-gap buncher can improve the overall gain by about 6 db. The theoretical results were confirmed in a positive-ion klystron operating at a frequency of 5 Mc. (auth)

**22321** SPEER CARBON RESISTORS AS THERMOMETERS FOR USE BELOW 1°K. W. C. Black, Jr., W. R. Roach, and J. C. Wheatley (Univ. of Illinois, Urbana). Rev. Sci. Instr., 35: 587-91(May 1964). (TID-20084)

A survey was made of the properties of certain resistors made by the Speer Carbon Company to determine whether they might be suitable for resistance thermometry below 1°K. It is found that resistors of grade 1002 in various nominal resistance values from 100 to 500 Ω are the most suitable for very low temperature work. Resistors of the

same nominal size matched at room temperature and at 4°K have rather similar characteristics down to 0.02 to 0.03°K. The resistors may also be baked at a sufficiently high temperature to allow them to be sealed into apparatus using thermocuring epoxy resins. A magnetic field perpendicular to the axis of the resistors decreases the resistance at constant temperature. (auth)

**22322** THREE-PHASE SUPERCONDUCTING MOTOR. J. D. Jones and P. W. Matthews (Univ. of British Columbia, Vancouver). Rev. Sci. Instr., 35: 630-3(May 1964).

A three-phase motor is described that has one or more loops of superconductor for its rotor and uses superconducting field coils. The theory of the motor is outlined, including the case when flux is frozen into the rotor. The predictions of the theory are compared with the experimentally observed torque produced by the motor. (auth)

**22323** LIFE TESTING OF ac HEATED TUNGSTEN FILAMENTS IN STRONG MAGNETIC FIELDS. G. Martin (Princeton Univ., N. J.). Rev. Sci. Instr., 35: 640-1(May 1964). (MATT-229)

The rapid filament-failure in the case of a fast ion gage designed for use on the C-Stellarator prompted the study of ways to increase the lifetime of resistance-heated tungsten filaments in strong magnetic fields where destruction is brought about by the ($j \times B$) force. The frequency of the heater current was increased until the frequency of the forced motion was acceptable for tungsten wire wound to form a helix. Temperatures of 2600 and 2350°K and 10- and 50-kc power sources were used for $B = 0.7$ W/m$^2$. (R.E.U.)

**22324** ON THE NONLINEAR THEORY OF THE PLANE TRAVELING-WAVE TUBE. S. Olving (Chalmers Tekniska Högskola, Göteborg). p.205-34 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

An infinitely wide electron beam interacts with an infinitely wide homogeneous slow wave structure; thus the difficulties associated with radial boundary conditions are avoided. The nonlinear wave equation is solved to the third order by the method of successive approximations. The one-valued velocity assumption limits the analysis to the range well below the saturation level. Within this range, however, the results describe such effects as the dependence of fundamental frequency gain and output phase on drive power, and the production of the first two harmonics. Furthermore, it is shown that by the use of suitable approximations one can write the nonlinear plane TWT equation in a form very similar to the exact nonlinear plane klystron equation. From this point on, one can deal with the plane TWT by the methods that have already been successfully applied to the plane klystron case. (auth)

**22325** CERN GENERAL PURPOSE CHASSIS (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1104)

Fourteen drawings are included for a chassis system that standardizes the packaging of hardware used in reactor control systems. The plug-in chassis and plug-in card modules are designed so that each item may be constructed in many different sizes. All dimensions are given in millimeters but factors for conversion to inches are included on each drawing. (P.C.H.)

**22326** MULTIPLIER PHOTOTUBES FOR SINGLE ELECTRON COUNTING. E. H. Eberhardt (International Telephone and Telegraph Corp., Fort Wayne, Ind.). 19p. (CONF-182-13)

From 9th Scintillation and Semiconductor Counter Symposium, Washington, D.C., Feb. 1964.

Typical operating characteristics of special purpose multiplier phototubes are described, with particular emphasis on the ability of these tubes to count single photoelectrons with minimum interference from dark noise. This ability is of particular significance in the detection of low-energy quanta, including single photons. It follows from the Poisson-like output pulse height distribution, in which a well-defined most probable pulse amplitude appears, compared to a more complex but lower amplitude dark-noise pulse-height spectrum. Other features of these tubes, such as adjustable cathode size and shape, electrical deflection for automatic gain calibration, alignment and image tracking, and reduction of dark noise with cooling, are also described. (auth)

**22327** IMPROVEMENTS IN OR RELATING TO MEASURING DEVICES. Eric Brayton Bell (to Saunders-Roe & Nuclear Enterprises Ltd.). British Patent 957,186. May 6, 1964. Filed Aug. 17, 1960.

A radiation detection instrument is described whose purpose is the measurement of radiation passing from a source through a sampling zone (e.g., the measurement of radiation transmitted through a material whose density is being monitored). The instrument is provided with a second source and an automatic calibrating circuit. This circuit calibrates the detector by comparing the responses of the detector to the first and second sources. (T.F.H.)

**22328** NEGATIVE ION GENERATOR USING AN ULTRAVIOLET SOURCE TO IRRADIATE ELECTRICALLY CONDUCTIVE MATERIAL. Charles L. Allen and Allen R. Taylor (to Dynamics Corp. of America). U. S. Patent 3,128,378. Apr. 7, 1964. Filed Oct. 4, 1960.

A large quantity of negative ions may be generated by irradiating an electrically conductive metallic mesh or screen with ultraviolet light. The screen is mounted adjacent to an ultraviolet lamp within a housing. At the other end of the housing is mounted a fan or blower for forcing air past the lamp and through the screen. Thus, electrons photoelectrically ejected from the screen collide with air molecules and produce negative oxygen ions, which are carried away into the surrounding atmosphere. A second screen placed between the fan and the lamp and maintained at a potential positive with respect to the emitter screen will increase the total negative ion output by as much as 30%. (A.G.W.)

**22329** MULTIPLE RADIATION SOURCE MICROSCOPE. Elmer Pierre Nemes. U. S. Patent 3,129,353. Apr. 14, 1964. Filed May 17, 1960.

The microscope described includes sources for simultaneously producing electromagnetic energies from ultraviolet down to and including the radiofrequency range and for producing energy in the form of $\alpha$, $\beta$, and $\gamma$ rays. The various energies are directed onto the specimen being examined, and the specimen in turn emits radiation characteristic of its nature. The radiation emitted by the specimen modulates the other energies to form a composite radiation pattern. Means are provided for converting the composite radiation pattern into a visible image. (A.G.W.)

**22330** ELECTROMETER UTILIZING A-C AND D-C VOLTAGE BALANCING. Francis R. Shonka (to U. S. Atomic Energy Commission). U. S. Patent 3,133,248. May 12, 1964.

An electrometer having first and second deflecting electrodes and a cantilever mounted movable fiber is described

Means are provided for applying an a-c voltage to the deflecting electrodes and means are also provided for applying a d-c voltage to said cantilever mounted movable fiber. The applied a-c and d-c voltages are varied to cause the fiber to remain at rest with no input signal applied thereto. (AEC)

## Radiation Detection

**22331** (CLOR/IBJ-II-22) THE BACKGROUND COUNT IN LARGE-AREA SEMICONDUCTOR SURFACE-BARRIER DETECTORS. J. Roman (Poland. Biuro Peinomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw) and J. Chwaszczewska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 17p.

The background count in silicon surface-barrier detectors, of several square centimeters in sensitive area, for use in bio-assay and in alpha spectrometry was investigated. Some of the factors contributing to the count were reviewed. Background count fluctuations in long-time operation were observed. It was found that the detectors, under optimum operating conditions, have a background counting rate of less than 0.001 cpm. (auth)

**22332** (CONF-481-46) SUBNANOSECOND RC RISE-TIMES FROM IONIZATION COUNTERS. A. DeVolpi, K. G. Porges, and C. Rush (Argonne National Lab., Ill.). 1964. 13p.

From American Physical Society Annual Meeting, New York, Jan. 1964.

Some fission fragment ionization counters, designed for fast electron collection, were operated with computed RC risetimes of 100 psec. Natural pulse widths are 10-20 nsec; signal amplitudes are enough above noise to permit operation on a plateau in integral bias. No pre- or post-amplification is required to bring the lowest energy fragments from $^{252}Cf$ into the 100 mv range of the tunnel diode discriminator used in testing. By impedance matching at the amplifier input, very long lengths of coaxial cable may be interposed between the detector and the amplifier, suffering only the characteristic frequency-dependent attenuation of the cable. Some implications of this mode of operation, for example, in the vicinity of high radiation sources, as well as applications to other detectors, are discussed. Photographs of operation, spectral response curves, noise measurements, and circuitry are included. (auth)

**22333** (CONF-503-1) HIGH-SPEED PULSE AMPLIFIER-DISCRIMINATOR. Fred H. Sawada (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 24, 1964. Contract W-31-109-eng-52. 10p.

From General Electric High Frequency Measurement Symposium, New York, Mar. 1964.

High-frequency circuit design utilizing stripline technique reduces counting losses and total resolving time of the electronic system for an electron multiplier tube. The tube is used for direct ion detection in a mass spectrometer. The stripline technique simplifies network design; and stable, wide-band operation is achieved without elaborate neutralization. The analysis of the potential stability of the active two-port network in stripline configuration is presented. The operation of the circuit is outlined. (auth)

**22334** (HW-74913) LOG N AND PERIOD METER, SERIAL NO. 203—INSTRUMENT EVALUATION REPORT. G. L. Erickson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 14, 1962. Contract AT(45-1)-1350. 41p.

The log level and period meter, a solid-state instrument designed to monitor reactor neutron flux between startup and full-power, was re-evaluated after some modifications. The instrument indicates relative power level and the reactor period in seconds from the current signal of a gamma-compensated, neutron-sensitive ion chamber over the ion current range $10^{-11}$ to $10^{-3}$ amp. The operating characteristics of the instrument were determined, and it was found to meet, essentially, the performance specifications provided to manufacturers. The instrument has operated 10,000 hours without failure and with good short- and long-term stability. (D.C.W.)

**22335** (HW-80020(p.14-22)) ANALYSIS OF A NEUTRON CHOPPER TO BE USED WITH THE HTLTR. R. J. Hoch (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

An analysis was performed to select the dimensions and operating parameters of the chopper. The work performed is outlined, and a pictorial model used in the analysis is discussed. The chopper will have a flight path of 25 m and will feature rotor slits with adjustable effective area. (D.C.W.)

**22336** (LA-3001) THE DEVELOPMENT OF FILM BADGES CONTAINING MULTI-ELEMENT FILTERS TO REDUCE THE X-RAY ENERGY DEPENDENCE OF PHOTOGRAPHIC FILM. Ellery Storm and Simon Shlaer (Los Alamos Scientific Lab., N. Mex.). July 1961. Contract W-7405-eng-36. 107p.

The experimental work leading to the development of flat roentgen response film badges containing multi-element filters is described. The films were exposed to fluorescent x rays from 30 to 100 kev, heavily filtered direct x-ray beams from 100 to 250 kev, and isotope gamma rays from 250 to 1250 kev. Measurements showed that the unfiltered response of personnel films was 15 to 30 times greater to 40-kev x rays than to 1250-kev gamma rays. Calculations indicated that a filter consisting of several elements with K-edges evenly spaced from 40 to 90 kev could reduce the energy dependence of the film to within acceptable limits. Such multi-element filters were placed in cycolac plastic film badges. It was necessary to place Cu between the multi-element filter and the film to reduce the effects of fluorescent radiation produced in the filter. Measurements made with low-energy radiation showed that the film blackening behind the filter was due primarily to radiation scattering in the plastic and not to radiation passing directly through the filter. Two plastic film badges were developed with either Pb frames or Pb lattices placed around the filters to reduce the amount of radiation scattering into the filtered area. The Pb-frame badge contains a multi-element filter (Gd, Er, Ta, Au, and Bi) and a 0.02-in. thick Cu filter. The response of Du Pont 502, Du Pont 508, Du Pont 555, Eastman Type II, and Ilford PM-1 film in this badge is flat within 30% from 40 to 1250 kev; the badge is directionally independent within 30% over this energy region, but the density under the filtered area at low energies is nonuniform, the edges being darker than the central region. The Pb-lattice badge contains a multi-element filter (same elements as in the frame badge, but in different proportions) and a Cu filter whose thickness varies with the film type; the response of the same films listed above is flat within 30% from 50 to 1250 kev; it is directionally dependent at low energies, and the density under the filtered area is uniform. (auth)

**22337** (NDL-TM-14) A CRITICAL APPRAISAL OF THE ADEQUACY OF EXISTING COMBAT DOSIMETRY. Robert C. Tompkins (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Apr. 1964. 18p.

An examination was made of experimental and theoretical evidence bearing on the ability of the IM-93 and DT-60 military combat dosimeters to indicate the initial radiation dose (neutron and gamma) from nuclear detonations. The IM-93 is a condenser-ion chamber tactical dosimeter and the DT-60 is a Ag-activated phosphate-glass individual dosimeter. It was concluded that neither dosimeter can indicate the combined dose within the required accuracy, regardless of the reference dose used. (C.H.)

**22338** (NVO-162-5) RADIATION TELEMETERING CONCEPTS AT THE NEVADA TEST SITE. R. L. Hill, B. L. Brown, and V. M. Milligan (Reynolds Electrical and Engineering Co., Inc. Health and Safety Div., Mercury, Nev.). Oct. 1963. Contract AT(29-2)-162. 10p.

Various applications of radiation telemetry have been developed and used successfully to assay extremely hazardous and critical areas following underground and surface detonations. Multi-detector systems with range capabilities from 0.5 mr/hr to 500 r/hr and from 10 mr/hr to 10,000 r/hr, continuously monitoring all locations of concern, can be emplaced and calibrated in a matter of hours. Ion chamber detectors, hard wire linked by telephone trunk lines to doserate meters at a central console, can transmit radiation data up to thirty-five miles. The continuous and direct read out capability of this system, with the optional recording incorporated, provides a valid means for quick evaluation of a source problem at zero exposure to personnel. For example, discernment of deposited contamination versus escaping radioactive effluent can be readily determined by observing the meter response as a function frequently indicated by short term decay evaluation. Extremely important early radiological data, otherwise impractical due to personnel exposure limitations, cumbersome installation requirements and costs, has been made immediately available and involves no personnel exposure hazard. Installation can be accomplished in a matter of hours by two or three trained technicians. Costs become nominal after initial development because complete re-installation of a system can be accomplished by movement of the detector, simple field wire hook-up with telephone lines, and recalibration of the system. (auth)

**22339** (PAN-440/IX) POMIARY BEZWZGLEDNE GESTOSCI NEUTRONOW TERMICZNYCH METODA AKTYWACYJNA Z ZASTOSOWANIEM SCYNTYLATOROW CIEKLYCH (theses). (Absolute Thermal Neutron Density Measurements by the Activation Method Using Liquid Scintillators (thesis)). Edward T. Jozefowicz (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 128p.

The details of the method of absolute beta activity measurements by dissolution of the active sample in liquid scintillators and extrapolation of the integral bias curves to the zero point of discrimination are worked out. This method was used for the absolute thermal neutron density measurements by the activation method using P, Na, I, Mn, and In. For all these elements the complete procedure is given, including the preparation of the detectors, irradiation and dissolution in liquid scintillators. It is based on solubility and relative pulse height measurements. Some results obtained in the WWR-S reactor at Swierk are given. Neutron densities in the range from $10^{-2}$ to $10^{9}$ n/cc can be measured with the accuracy of 4%. The method was also used to measure the thermal neutron activation cross sections of P, I, and In in relation to Na and Mn. (auth)

**22340** (PAN-455/IA) SPEKTROMETR SCYNTYLACYJNY DLA PROMIENIOWANIA γ O MALEJ ENERGII Z ZASTOSOWANIEM TECHNIKI KOINCYDENCYJNEJ I SUMOWANIA. (Coincidence Spectrometer with Energy Summing for Low-Energy γ Rays). E. Lyudzeevskii and Ya. Byalkovskii (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 21p.

A fast coincidence circuit, gate, and linear summing circuit are described. The efficiency and resolving time of the coincidence circuit are 100% and 24 nsec, respectively, for gamma energies of about 50 kev. For gamma energies of about 16 kev, the efficiency is about 90%. The gate is linear up to 100 v. The maximum value of the gate plateau is 0.5 v. Each branch of the summing circuit gives linear pulses up to above 100 v. (auth)

**22341** (PAN-484/II) OTRZYMYWANIE KRZEMOWYCH DETEKTOROW PROMIENIOWANIA JADROWEGO METODA DYFUZJI FORSFORU. (Preparation of Silicon Nuclear Particles Detectors by Phosphorus Diffusion Method). Vintsent Pshyborski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 22p.

The technology of silicon p-n junctions based on the thermal diffusion method is summarized, and a method of passivation of surfaces is described. A space charge layer width of ~100μ, a dead layer thickness of ~0.2μ, and a resolution of ~2% have been obtained. (auth)

**22342** (RISÖ-70) INTERPRETATION OF LOW-ACTIVITY COUNTING. J. Thomas (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Nov. 1963. 60p.

Thesis submitted to Universitet, Copenhagen.

The problem of estimating the unknown activity of a radioactive source is discussed. The estimate is based on the information that the radioactive source plus the background of the detector give the count number $n_1$ in a certain time interval, and that the background alone gives the count number $n_2$ in a period of the same length. Further it is assumed that the activity of the radioactive source is positive or equal to zero. The mean value and the standard deviation of the probability distribution of the unknown activity are derived from these assumptions, and tabulations are made and approximative expressions derived for practical use. (auth)

**22343** (RSA-39) EN UNDERSÖKNING AV DE FAKTORER SOM HAR INVERKAN PA GASFÖRBRUKNINGEN I EN PROPORTIONALRÄKNARE MED STRÖMMANDE GAS. (Investigation of the Factors that Determine the Gas Consumption of a Flow-Gas Mylar Window Proportional Counter). Sven Malmskog (Aktiebolaget Atomenergi, Stockholm). May 6, 1960. 33p.

Gas consumption by Mylar windows used in flow counters was investigated. Effects of gas flow rate, temperature, pulse selection, mean electron energy, and methane-air mixture composition were determined. Results are presented in graphs. (M.C.G.)

**22344** (UCRL-11184(p.69-85)) SCINTILLATION CAMERA WITH 11-INCH CRYSTAL. Hal O. Anger (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

A brief general description is presented of the scintillation camera and the three types of image-producing collimators that can be used with it. A detailed description is given of the new image detector that uses a NaI crystal,

11½ in. in dia by ½ in. thick, and a bank of 19 phototubes. The circuits that compute the position of scintillations are also described in some detail. Examples of pictures taken with the instrument show the results obtained in clinical use with the various collimating methods. (auth)

**22345** (UCRL-11184(p.86-90)) GAMMA-RAY-DETECTION EFFICIENCY AND IMAGE RESOLUTION IN SODIUM IODIDE. Hal O. Anger and Donald H. Davis (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

Photoelectric, Compton, and photopeak efficiencies are calculated at several gamma-ray energies for large flat NaI crystals in which the thickness ranges from one-eighth to two inches. In addition, the loss of position resolution by gamma-ray scattering within the scintillator is calculated because of its importance in the design of gamma-ray imaging devices such as the scintillation camera. An examination of the data shows the advantage of using low-energy gamma rays for imaging whenever possible. These gamma rays are efficiently detected by solid NaI scintillators half an inch thick with little loss of position resolution from multiple scattering of gamma rays in the scintillator. In the higher energy range, a choice must be made between a thin scintillator with its relatively good position resolution and low detection efficiency, or a thick crystal with higher detection efficiency and less satisfactory resolution. (auth)

**22346** (USNRDL-TR-719) ESTIMATES OF RADIATION GEOMETRY AND ENERGY RESPONSES FOR THE USNRDL "MODEL 1954-56" GAMMA-INTENSITY-TIME RECORDER (GITR). H. R. Rinnert (Naval Radiological Defense Lab., San Francisco). Jan. 22, 1964. 108p.

The GITR that was used to obtain radiation data at Operations Castle, Wigwam, and Redwing consisted of an unshielded four-detector installation connected by cable to a remote recorder. Its responses to gamma radiation were estimated for several idealized source geometries and a variety of calculated gamma energy spectra as a function of time. The estimated values of GITR response to radiological environments likely to be encountered in the field did not appear to depend significantly upon time after fission or upon exact knowledge about energy spectra or source geometries. (D.C.W.)

**22347** (EURAEC-1008) SOLID-STATE NEUTRON DETECTOR. Quarterly Report No. 1, October 1–December 31, 1963. (Centre d'Etude l'Energie Nucleaire, Mol, Belgium). Work performed under United States–Euratom Joint Research and Development Program. Contract 099-63-10/RDB. 11p. (R-2270). (A translation)

The equipment for measurement of the counting characteristics, the I–V characteristics, the capacity, the photocurrent, and the photovoltage of SiC n–i–p surface barrier counters is discussed. Measurements of these properties are presented. (auth)

**22348** A NEW METHOD FOR PHOTOGRAPHIC REGISTRATION AND EVALUATION OF THE TEMPORAL COURSE OF COUNTING RATES. H. Melcher and E. Gerth. Atomkernenergie, 9: 133-4(Mar.-Apr. 1964). (In German)

The greywedge method of evaluation of γ-spectrograms by means of equidensities is shown to be applicable with some alterations to evaluation of the temporal course of the counting rate. It is shown that the emitted light from the discharge in the GM-counter tube can be used as a photographic recorder for counting rates. Some examples of applications are given. (auth)

**22349** THE BEHAVIOR OF GLASS SCINTILLATORS. H. Schneider and K. Woelcken (Justus Liebig-Universität, Giessen, Ger.). Atomkernenergie, 9: 135-6(Mar.-Apr. 1964). (In German)

Some investigations on cerium-activated glass scintillators are reported. The scintillations of the glasses were measured under irradiation with monoenergetic electrons of 625 kev and with α particles of energies between 0.1 and 5.28 Mev. The efficiencies are comparable to the efficiency of a good plastic scintillator. (auth)

**22350** ON THE APPLICATION OF TRIPHENYLTETRAZOLIUMCHLORIDE FOR MEASUREMENTS OF THE DOSE-DISTRIBUTION. Th. Gruenewald and W. Schmidt-Lorenz (Bundes-forschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atomkernenergie, 9: 143-7(Mar.-Apr. 1964). (In German)

In the application of electrons or x rays with low penetrating depth, e.g., for therapeutic or biological purposes, the dosimetry is comparatively difficult. Instead of the ionization chamber, therefore, different chemical dosimeters mostly in the form of aqueous solutions of a substance are used with films, showing a discoloration after irradiation. The possibilities of the application of triphenyltetrazoliumchloride (TTC) as a dosimeter. When irradiating an aqueous solution buffered with tri-ethanolamine, red formazane is formed corresponding to the dose, which can be used quantitatively for the determination of the absorbed dose. For better evidence of the dose distribution and in order to detect the locally absorbed dose, the TTC-solution can be solidified by agar-gel. The formazane formed by irradiation can easily be determined in the laboratory by extraction or by local extinction measurements in the agar layer. Up to a dose of about 12 Mrad, there is a linear function between the formed formazane and the absorbed dose in a large range of dose rates. (auth)

**22351** THE RESPONSE TO 14 Mev NEUTRONS OF SOME CHEMICAL DOSIMETER SYSTEMS. W. A. Armstrong and W. G. Humphreys (Dept. of National Defence, Ottawa). Can. J. Chem., 42: 1092-7(May 1964).

The response to 14 Mev neutrons of $10^{-3}$ M ferrous sulfate–0.4 M $H_2SO_4$, $10^{-4}$ M ceric sulfate–0.4 M $H_2SO_4$, $10^{-3}$ M calcium benzoate, and $10^{-4}$ M terephthalic acid–$4 \times 10^{-4}$ M NaOH solutions was investigated. G values as follows: G(Fe III) = 10.5 ± 0.2, G(Ce III) = 3.13 ± 0.06, G(salicylic acid) = 0.316 ± 0.006, and G(hydroxyterephthalic acid) = 0.474 ± 0.007. The results were compared with those obtained when the same solutions were irradiated with $^{60}Co$ γ rays. Although the response to 14 Mev neutrons is only about one half the response of $^{60}Co$ γ radiation, the calcium benzoate and the terephthalic acid systems can measure doses as low as 20 and 2 rads, respectively. (auth)

**22352** THE APPLICATION OF RADIOACTIVE RADIATION SOURCES IN THE TEXTILE INDUSTRY. PART V. THE POSSIBILITY OF APPLICATION OF β-COUNTING TUBES. A. Heger and P. Sonntag (Universität, Dresden). Faserforsch. Textiltech., 14: No. 1, 34-43(Jan. 1963). (In German)

Because the textile industry uses predominantly β emitters, the action of β particles and the methods of counting must be understood in order to realize the limits of applicability of β-counters. A discussion is presented of the theoretical basis of β counters (proportional and Geiger counters) with emphasis on the effect of dead time and recovery time on the accuracy of counter response to particle flux. In order to make correct measurements, the instrument's dead time, which must be known, can be de-

termined by means of an oscillograph. There are numerous $\beta$ counters commercially available, but the choice of the counter depends on its application. The statistical character of $\beta$ decay and avalanche formation in Geiger counters makes the application of statistical methods in the evaluation of counter responses essential. The use of the Poisson distribution and formulas for calculating the counting errors are discussed. (OID)

**22353** AN AUTOMATIC FILM-BADGE DENSITY READER. P. Amadesi, G. Busuoli, A. Cavallini, and O. Rimondi (CNEN, Bologna, Italy). Health Phys., 10: 273-7(Apr. 1964).

An automatic densitometer for measuring density of films used in photographic personal dosimetry was designed and set up. Its main features are: high sensitivity, i.e. the minimum detectable difference in density is small; a wide range of blackening; and good long-term stability. Film reading, printing out, and reloading operations are fully automatic. The photosenaitive part is a photoresistor. (auth)

**22354** THE INTEGRATING IMPACTOR. A MONITOR FOR AIRBORNE ALPHA EMITTERS. G. W. C. Tait and J. Beal (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys., 10: 279-82(Apr. 1964).

A monitor for airborne $\alpha$-emitters is described that provides warning on a continuous basis. The sensitivity is adequate for protection of workers against $^{239}Pu$ to the standard called for the ICRP. The effects of natural background are eliminated. (auth)

**22355** MEDIUM SPEED COINCIDENCE CIRCUIT USING TUNNEL DIODES. J. H. Thorngate (Oak Ridge National Lab., Tenn.). Health Phys., 10: 283-4(Apr. 1964).

A coincidence circuit using tunnel diodes was designed that is applicable to a large number of medium speed coincidence applications. The circuit requires negative input pulses of 0.25 v minimum with a minimum duration of 50 nsec. By changing the polarity of the coincidence gate and using transistors that are complementary to those used, a positive pulse with the same requirements could be used for the input. Pulses arriving in coincidence at the inputs initiate an 8-v positive-going output pulse of 2 $\mu$sec duration. With a crossover pick-off gate providing the input to the coincidence circuit, resolving times of better than 0.1 $\mu$sec were easily obtained. (P.C.H.)

**22356** INSTRUMENT DEVELOPMENT. Isotopes Radiation Technol., 1: No. 3, 268-74(1964).

The use of a Geiger counter to determine tritium as water vapor is described. The method is applicable to continuous tritium-tracer monitoring for either process control or health physics. A schematic sketch is included of a system for the flow counting of tritium as water vapor. The use of bundles of plastic scintillating fibers coupled to a photomultiplier tube for low-energy $\beta$ counting is discussed. Results of tests on various fibers indicated that a fiber 0.5 mm by 1.5 in. showed the greatest counting efficiency. (10 references). (C.H.)

**22357** GAMMA-RAY RESPONSE OF SIMPLE SLIT-COLLIMATED DETECTORS. Arne L. Lillegraven (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Appl. Phys., 35: 1974-82(June 1964).

Formulas were developed for the direct gamma-radiation (photopeak) response of a simple slit-collimated crystal detector as a function of position and gamma-ray energy of point sources that are embedded in isotropic absorbing matrices. Apart from optical considerations, the effects of edge penetration, crystal absorption, source matrix absorption, and for higher energies, penetration of the collimator wall were taken into account. A comparison between measured and calculated response curves was made. (auth)

**22358** CONVERSION FACTOR CALCULATIONS FOR IONIZATION CHAMBER DOSE DETERMINATION AS FUNCTION OF THE GEOMETRY. A. Baudisch, M. Peschel, and K. Willuhn (Deutsche Amt für Messwesen und Warenprufung, Berlin). Kernenergie, 7: 166-72(Mar. 1964). (In German)

Conversion of dose rates determined by means of a standard chamber to those read in a field instrument was studied. The conversion factor was calculated for a spherical-chamber field instrument. The radiation source was considered in terms of a single point in these calculations. Relations between radius length of different spherical chambers and distance between radiation source and center of the chamber were calculated and presented both in a graphical manner and in the form of an equation. (P.C.H.)

**22359** ABSOLUTE MEASUREMENT OF RADIOACTIVE MATERIALS. II. MEASUREMENTS WITH A $\beta-\gamma$ COINCIDENCE SCINTILLATION DEVICE AND WITH A $4\pi\gamma$ IONIZATION CHAMBER. István Dézsi and István Fehér (Central Physics Research Inst., Budapest). Magy. Fiz. Folyoirat, 11: 517-28(1963). (In Hungarian)

Many measurements, such as the determination of preparations containing large amounts of carrier material and the direct measurement of the activity of closed $\gamma$ sources in the 10 to 100 $\mu$C region, could not be carried out conveniently by means of the previously described $4\pi-\beta$ proportional counter. It was therefore decided to develop a complete set of instruments, which could be also employed for exact determination of the $\gamma$-dose standards and of the absolute thermal neutron flux. A $\beta-\gamma$ coincidence counter and a $4\pi-\gamma$ ionization chamber were built to supplement the available $4\pi-\beta$ proportional counter. Comparative values were obtained by participation in the international $^{131}I$ standardization study, sponsored by the IAEA. The results obtained agreed well with the weighed "world average." The activity of $^{111}Ag$ colloidal solutions was determined by means of the $4\pi-\gamma$ ionization chamber and the data compared with those obtained with the $4\pi-\beta$ counter; the ionization chamber yielded more precise and more reproducible results. The instruments developed during the study were found useful for the determination of most of the $\alpha$-, $\beta$-, and $\gamma$-emitting isotopes in the activity range from 0.001 $\mu$C to 100 mC. (TTT)

**22360** DETERMINATION OF THE OPTIMUM NUMBER OF MEASUREMENT POINTS IN THE CASE OF AN INTENSITY FUNCTION WITH SEVERAL UNKNOWN PARAMETERS. Ferenc Balatoni and Péter Király. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 85-94(1964). (In Hungarian)

It is assumed that for a time-independent ray intensity depending upon N unknown parameters (to be measured) and a single arbitrary one to be planned, the number of counts for any fixed system of parameter values obeys Poisson's distribution law. The measurement aims at the most accurate estimation of any of the unknown parameters within given total measurement time. The estimate can be inferred from the number of counts taken over different time intervals, also to be planned, at M different points, that is at M different values of the arbitrary parameter. It is shown that if the parameter in question can be esti-

mated at all, the optimum estimate is obtained for $M \leq N$, that is with $M > N$ the estimation cannot be improved. The practical value of this theorem is pointed out. (auth)

**22361** A METHOD OF DETERMINING DOSE FIELD IN A HOMOGENEOUS PHANTOM FROM DISTANCE $Co^{60}$ GAMMA-UNITS. T. G. Pavlova (Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 9: No. 3, 24-32(Mar. 1964). (In Russian)

A method is proposed for determining the distribution of the dose field in tissue for different fields and various distances of a gamma emitter. Data of the tables furnished make it possible to determine the dose distribution in the tissue to a depth of 30 cm for fields ranging from 16 to 150 $cm^2$, with the emitter using a focus distance from 40 to 100 cm. Utilizing the above-mentioned information one could vary widely the conditions of irradiation during the choice of the irradiation technique. (auth)

**22362** COINCIDENCE SPECTROMETER WITH ENERGY SUMMING FOR LOW ENERGY $\gamma$-RAYS. J. Ludziejewski and J. Bialkowski (Inst. for Nuclear Research, Warsaw). Nukleonika, 8: 843-52(1963). (In Russian)

A fast coincidence circuit, gate and linear summator are described. The efficiency of the fast coincidence circuit and its resolving time are 100% and 24 nsec, respectively for $\gamma$ energy about 50 kev (for $E \simeq 16$ kev the efficiency is ~90%). The gate is linear up to 100 v. The maximal value of the gate pedestal is 0.5 v. Each branch of the summator gives linear pulses up to above 100 v. (auth)

**22363** NEUTRON DECAY SPECTROMETER. R. A. Karam and T. F. Parkinson (Univ. of Florida, Gainesville). Rev. Sci. Instr., 35: 600-5(May 1964).

The neutron decay spectrometer depends on the spectral analysis of protons from the decay of neutrons to determine the energy distribution of the neutrons. It comprises a containment magnet for confining the decay protons, a magnetic analyzer, and a detection system. It is shown that the average speed of the decay protons is equal to the speed of the parent neutron. The spread in the speed of the protons from the decay of monoenergetic neutrons determines the resolution possible with this method of spectrometry. The calculated energy spread varies from 30 to 2.7% over the neutron energy range 10 kev $\leq E_n \leq$ 5 Mev. The instrument was used to measure the neutron spectrum of the University of Florida Training Reactor, and the 1/E distribution was obtained and compared with the calculated spectrum. (auth)

**22364** MEASUREMENT OF X-RAY BEAM QUALITY WITH SOLID-STATE DETECTORS. Gordon Kramer (Avco Corp., Norman, Okla.). Rev. Sci. Instr., 35: 607-8(May 1964).

The ratio of the currents generated in two solid-state detectors of different lengths by a beam of x rays parallel to the junction is a measure of the x-ray beam quality. Two detectors with lengths of 0.16 and 1.6 cm, respectively, were used to measure x radiation varying in quality from a half value layer of 2 to 7 mm Al. (auth)

**22365** NONSATURATING QUANTAMETER FOR VERY HIGH INTENSITY GAMMA-RAY MONITORING. H. Fischer and C. Schaerf (Stanford Univ., Calif.). Rev. Sci. Instr., 35: 615-17(May 1964).

A type of gamma-ray monitor is described that is capable of handling the very high intensities now available from linear electron accelerators. This device provides an output proportional to the incident power. Unfortunately, it is not an absolute monitor. (auth)

**22366** DETERMINATION OF THE RADON CONTENT IN THE ATMOSPHERIC AIR BY THE METHOD OF ADSORPTION WITH ACTIVATED CHARCOAL. D. P. Shirshov. Sb. Rabot po Nekotorym Vopr. Dozimetr. i Radiometr. Ionizir. Izluchenii, No. 2, 150-6(1961).

Radon concentrations in the air of $\sim 10^{-13}$ C/l were determined with an SG-1M electrometer with an ionization chamber and an error of ~10%. Glass ampoules 2 cm in diameter with a layer of granular activated charcoal between two wads of glass wool were used to take samples. Forty liters of air, dried with $CaCl_2$, was pumped through a layer of charcoal 20 cm long with an aspirator. The ampoule was wrapped in moist gauze to prevent overheating of the charcoal. Rn was transferred to an evacuated ionization chamber, by connecting the ampoule with charcoal to it and heating the latter in a Mars furnace at a temperature of 400°C for 1 min. A second chamber was connected in series as a control. The procedure was checked by measuring the Rn activity diluted by air to a definite degree. Background readings from Ra contained in the charcoal corresponded to $\sim 3 \times 10^{-14}$ C/l. (Referativnyy Zhurnal, Khimya, 24, Dec. 1963)

**22367** MEASUREMENT TECHNIQUES FOR THE CONTROL OF EFFICIENCY AND SAFETY OF A NUCLEAR CHEMICAL PLANT. P. Hutchins (United Kingdom Atomic Energy Authority). Trans. Soc. Instr. Technol., 16: 1-13 (Mar. 1964).

Radiometric instrument applications in nuclear chemical plants are reviewed. The use of in-line monitoring, in-line alpha monitors, drum samplers, gamma monitors, cooling water monitors, neutron monitoring, neutron profile monitors, gamma absorptiometers, gaseous sampling, and area radiation monitors is discussed. (P.C.H.)

**22368** A NEW GAS DISCHARGE TRACK DETECTOR-STREAMER CHAMBER. B. A. Dolgoshein and B. I. Luchkov (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 392-5(Jan. 1964). (In Russian)

A disadvantage of the usual spark chamber for observing the tracks of particles is that trajectories at angles greater than 30 to 40° from the direction of the field, E, are not registered. A gas discharge chamber is described, which offers an improvement in this direction. The essential feature is the use of an incomplete spark discharge. The indicator of the passage of a particle at a given point is not a spark, but a streamer resulting from the start of an electronic cascade. The track is seen as the locus of such short streamers. The actual visibility results from radiation from the plasma of the streamers. The chamber is a box $700 \times 500 \times 100$ $mm^3$ containing 0.3 to 1.0 atm of neon. A steady voltage and a pulsed voltage are applied, the maximum voltage being 460 kv. Pictures are shown of the tracks of cosmic particles in this chamber. It is stated that tracks are visible for any direction of travel of the particles with reference to the direction of the applied field, that the tracks are more uniform than for the spark chamber (thus allowing for greater precision in measuring angles and curvatures), and that the dead time is less than in the case of the spark chamber. (TTT)

**22369** FALLOUT MONITOR [Q-2256] (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1089)

Eight drawings are included for a fallout monitoring system. The collector-detector system consists of a disc covered with aluminum foil which rotates at 1 rpm. Fifty percent of the disc area is always exposed to collect fallout. As the disc rotates it carries the particles under a

shielded GM tube that counts the beta-gamma radioactivity and then under a scintillation-type probe that counts the alpha radioactivity. The GM tube is either a Lionel 106 C. or an Amprex 90N88. Drawings for the scintillation probe (Q-2101) are in CAPE-1131. (P.C.H.)

**22370** COINCIDENCE-ANTICOINCIDENCE CIRCUIT. Edgar Leiter (to Licentia-Patentverwaltungs GmbH). German Patent 1,160,005. Dec. 27, 1963. Filed Apr. 29, 1961.

The coincidence-anticoincidence circuit comprises at least two control circuits composed of discriminators and/or pulse shapers for each of the channels. When two control circuits are used, the output signal of the first circuit (control circuit in channel 1) is fed into the second circuit (control circuit in channel 2) in such a way that the signal flow in the second channel is either established or interrupted, depending on whether coincidence or anti-coincidence is to be detected, for a predetermined time. When a pulse arrives at the input of channel 2 during the said time interval in the first case, a signal will be produced at the output of the arrangement. An essential feature of this circuit is that it responds to the leading-edge of the trigger pulse. (Gmelin Inst.)

**22371** ARRANGEMENT FOR THE MEASUREMENT OF A NEUTRON FLUX DISTRIBUTION. J. Bekc (to Licentia Patentverwaltungs GmbH). German Patent 1,160,116. Dec. 27, 1963. Filed Mar. 23, 1961.

The arrangement comprises a plurality of ionization chambers of which at least two are aligned in axial direction with the help of a connecting pipe. In the center along the axis of the cylindrical ionization chambers there is an insulating tube provided with capillary tubes in which the connection cables of the collectors are located. All connections pass through one end of the insulating tube. (Gmelin Inst.)

**22372** HIGH-TEMPERATURE FISSION COUNTER FOR THE MEASUREMENT OF A NEUTRON FLUX. J. Erskine Sanders, Frederick Wade, R. Charles Hollick, and Derek Barnes (to United Kingdom Atomic Energy Authority). German Patent 1,160,957. Jan. 9, 1964. Priority date Dec. 11, 1959, Great Britain.

A coaxial-tube fission counter is described in which the counter chamber located on one end of the tube communicates with the rest of the tube where the insulator-supports and spacers are arranged. An essential feature of the counter is that the tube is filled with a mixture of gas that is composed chiefly of xenon. (Gmelin Inst.)

**22373** GAMMA RADIATION SCANNER AND AN AERIAL SURVEYING AND RECORDING SYSTEM UTILIZING THE SAME. Joseph C. Nirschl (to U. S. Army). U. S. Patent 3,128,380. Apr. 7, 1964. Filed Oct. 30, 1961.

The scanner comprises a central radiation detector surrounded by a stationary radiation shield with an angular cutaway section, the stationary shield being enclosed by a rotating shield including a plurality of radial radiation-admitting and collimating bores. As the outer shield is rotated, the radiation detector scans a strip of ground generally transverse to the aircraft's flight path. The radiation detector output is fed to a recording system, which produces a continuous photographic map of the $\gamma$ activity of the surveyed area. Preferably two scanners are mounted adjacent to each other and rotating together about a common axis with the teeth of one shield positioned midway between the teeth of the other. Thus the scanners scan alternate inter-leaved strips, and the scanning rate can be half the rate necessary when one scanner is used. (A.G.W.)

**22374** BROAD RANGE RADIATION METER CIRCUIT. Elmo J. Di Ianni (to Nuclear Corp. of America). U. S. Patent 3,129,333. Apr. 14, 1964. Filed Sept. 16, 1960.

Geiger-Mueller tubes are used in a three-range radiation detection circuit. For low field intensities, the tube is operated in a conventional manner. For intermediate fields, the tube is operated with normal polarities and pulses are used to periodically enable the tube. For very high fields, the potential is reversed and pulses are again used to periodically enable the tube. (A.G.W.)

**22375** TEMPERATURE CONTROLLED RADIATION GAGE. Claude A. Loflin and Charles B. Moore (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,129,334. Apr. 14, 1964. Filed Oct. 6, 1961.

A $\gamma$-radiation gage adapted to use in high-temperature environments is maintained at a predetermined low temperature by enclosure in a cooling jacket. The jacket is of $\gamma$-permeable material, and the coolant is stable under $\gamma$ radiation and substantially nonabsorptive of $\gamma$ radiation. Preferred coolants are saturated hydrocarbons containing up to two carbon atoms and substantially completely saturated with fluorine plus one other halogen element (chlorine or bromine). Coolant condensing means in communication with the cooling jacket receives vaporized coolant and returns condensed coolant. (A.G.W.)

**22376** RADIATION DETECTING WITH SHUTTER GLASS. Adli M. Bishay (to U. S. Atomic Energy Commission). U. S. Patent 3,134,019. May 19, 1964.

A shutter glass for a photocell to sense x, gamma, and high-energy ultraviolet rays is described. The latter causes the glass to darken by reason of its content of 0.5 to 5.0 mol percent cerium in cerous form. The darkening reduces the amount of light energy impinging upon the photosensitive element of the photocell, thereby affecting the current in its circuit. (AEC)

**22377** DEVICE FOR MEASURING AND RECORDING RADIOACTIVE RADIATION IN THE FREE ATMOSPHERE. A. F. Kuzenkov and T. T. Rytikova. Russian Patent 158,119.

A device for measuring and recording radioactivity in the free atmosphere is described. The principal components of this equipment are a Geiger-Mueller counter, converter, radio transmitter, and a radiotheodolite. A time-delay phantastron converts the signals from the Geiger counter into impulses of a given duration, which are then fed into an inverter. (OTS)

**22378** METHOD OF COMPENSATING THE ENERGY DEPENDENCE OF SCINTILLATION DOSIMETERS. A. N. Denisenko. Russian Patent 159,238.

A method for compensating the energy dependence of scintillation dosimeters is described. To utilize the linear dependence of the pulse amplitude on the radiation energy, the pulse from the output of the photomultiplier is converted into a control signal and then fed to the input of the photomultiplier to adjust its current in the direction of the energy dependence. (OTS)

# ISOTOPE TECHNOLOGY

## General

**22379** (NYO-10220) RADIOLOGICAL MECHANISMS FOR GEOPHYSICAL RESEARCH. Annual Report. Leonard L. Bird, John Papadopoulos, Roy A. Rex, and Charles A. Ziegler (Parametrics, Inc., Waltham, Mass.). Oct. 31, 1963. Contract AT(30-1)-2983. 67p.

A study was conducted to determine the optimum design parameters for a gage containing a $^{109}Cd$ $\gamma$ source and NaI scintillation counter for measuring the suspended sediment concentration in rivers and streams. A model of the sediment gage was constructed and successfully flume tested. Sediment concentrations in the range from 500 to 50,000 ppm were determined using various stream flow rates. The experimental results obtained and a theoretical analysis of gage performance are presented. Flight data were obtained on the performance of balloon-borne $\beta$-ray-scattering gages for measuring atmospheric density. (C.H.)

**22380** ISOTOPES AND RADIATION TECHNOLOGY. Volume 1, No. 3. P. S. Baker, Robert H. Lafferty, Jr., Martha Gerrard, and D. A. Fuccillo, eds. (Oak Ridge National Lab., Tenn.). Spring 1964. $0.55(GPO) (Domestic), 10.70(GPO) (Foreign). (One of the Technical Progress Reviews prepared Quarterly for the Divisions of Technical Information and Isotopes Development, USAEC).

Separate abstracts were prepared for 8 sections of this publication. (C.H.)

*For abstracts of individual sections see: 22289, 22356, 22381, 22382, 22384, 22385, 22386, and 22387.*

**22381** PRODUCTION AND APPLICATION OF SHORT-LIVED RADIOISOTOPES. Isotopes Radiation Technol., 1: No. 3, 207-24(1964).

Production methods and applications of short-lived radioisotopes are reviewed to indicate their potential value in medicine, industry, and research. Isotopes with half lives of one hr to three days are considered. Reactor production and production by isotope generators and milking from other radioisotopes are described. Advantages of using short-lived radioisotopes for many investigations are outlined. Numerous applications in basic research, industry, ventilation and meteorology, metallurgy, carbon paper evaluation, medicine, and biology are discussed. (89 references.) (C.H.)

**22382** ISOTOPE TECHNOLOGY DEVELOPMENT. Isotopes Radiation Technol., 1: No. 3, 225-44(1964).

A brief historical review is presented of applications of isotope technology in industry and research. Several recently developed uses of isotopes as tracers are described. These include an instrument using $^{131}I$ for the determination of flow of ocean currents, a new and better method for the introduction of tritium into organic compounds, and an engineering study of water flow using activation analysis tracing of a stable isotope, $^{56}Mn$. (78 references.) (C.H.)

**22383** STUDIES ON MICRO AMOUNT OF WATER IN OIL USING TRITIATED WATER. Kazuta Kitahara and Yoshimasa Tanaka (Univ. of Kumamota, Japan). Yakugaku Zasshi, 83: 559-60(June 1963). (In Japanese)

An isotopic method employing water-$t_2$ is described for measuring the rate of removal of water, contained in minute amounts (below $^1/_{1000}$) from oils and fats, and isotopic exchange between H and tritium was examined by the measurement of radioactivity of tritiated water with a liquid scintillation spectrometer. Dehydrated sesame oil was mixed with tritiated water, which was removed by reduced pressure at a definite temperature, and a sample was taken at definite intervals to measure the radioactivity, using a liquid scintillation spectrometer. Correlation between I (cpm) and t (hr) was found to be expressed by the formula $I = K/t^n$ (where K is a constant). At 130°, n was 0.59 and at 220°, 0.85. Isotopic exchange between H and tritium was very low after 60 hr. (BBB)

## Industrial Applications

**22384** USE OF ISOTOPES IN THE FOOD-CANNING INDUSTRY. Walter A. Mercer and Jack W. Ralls (National Canners Assoc., Berkeley, Calif.). Isotopes Radiation Technol., 1: No. 3, 245-55(1964).

Applications of isotopes in food processing research and quality control are reviewed. Applications discussed in detail include research on raw food and containers, quality control, autoradiography of crop samples treated with radioactive insecticides, research on food washing, and in the radiation processing of foods, with emphasis on the radiosensitivity of spores of Clostridium botulinum. (19 references.) (C.H.)

**22385** RADIOACTIVE PISTON RINGS FOR EVALUATION OF ENGINE OILS. Isotopes Radiation Technol., 1: No. 3, 255-6(1964).

The rate of piston-ring wear was measured with Fe rings inlaid with an electrolytically deposited alloy of Ni and $^{60}Co$, with reactor-activated Ni-inlaid rings, and with reactor-activated Fe rings. The tests were conducted with three types of engine oil in an air-cooled single-cylinder engine. The concentration of radioactive debris transferred to the lubricant was monitored continuously with a scintillation detector. It was found qualitatively that the three types of rings rated the three oils similarly with respect to ring wear. Difficulties of procedure and equipment are discussed. (C.H.)

**22386** ENGINE-WEAR STUDIES WITH RADIOISOTOPES. J. E. Brugger, F. F. Rieke, and R. A. Semmler (Univ. of Chicago). Isotopes Radiation Technol., 1: No. 3, 256-64(1964).

A comprehensive review is presented of the literature through 1961 on applications of radiotracers to piston-ring and cylinder-wear studies. Related topics covered include publications on bearing-journal and cam-tappet wear in engines, friction and wear studies of general interest, properties and formation of extreme-pressure-lubricant films, and lubricant loss and consumption in engines. (191 references.) (C.H.)

**22387** USE OF RADIOISOTOPES IN THE FOREIGN COAL INDUSTRY. George J. Rotariu (Division of Isotopes Development, AEC). Isotopes Radiation Technol., 1: No. 3, 264-8(1964).

Applications of radioisotopes in the foreign coal industry, as reported in the literature from 1958 to mid-1962, are reviewed. Applications discussed in detail include in exploration and prospecting, mining operations, processing, testing

and analysis, storage, handling, transportation, and research. (41 references.) (C.H.)

**22388** $Sr^{90}$–1C—IRRADIATION LABORATORY SOURCE. Josef Šimorda (Inst. of Rubber and Plastic Tech., Gottawaldov, Ger.). Jaderna Energie, 10: 78-81 (1964). (In Czech.)

A small experimental laboratory beta-irradiation source using strontium of 1-C activity is described. The source design is briefly described and attention is paid to beta and bremsstrahlung dose calculations with respect to convenient shielding design. The source was designed for irradiation of small samples in the investigation of radiation technology of plastics and rubber. (auth)

**22389** DESIGN OF A SETUP FOR RADIATION VULCANIZATION OF TIRES WITH THE USE OF $Co^{60}$ GAMMA RADIATION. V. K. Khozak, B. I. Vaynshteyn, N. A. Krasnoshchekova, A. Kh. Breger, M. Ya. Kaplunov, and N. P. Syrkus. Kauchuk i Rezina, No. 2, 20-3(1964).

Three variants of a setup were designed to effect radiation vulcanization of tires (260-20 and 6.70-15) with $^{60}Co$ gamma radiation. The variants are: a setup with one biplanar radiator of constant size (130 × 130 cm, 48 cm apart); a setup with one biplanar radiator of different size for each (same as 1 for the 260-20 tire; 100 × 100 cm, 40 cm apart for the 6.70-15 tire); and a setup with two biplanar radiators of constant size for each (the size of 1 for the 260-20 tire; the size of the second radiator in 2 for the 6.70-15 tire). The efficiency of each variant was computed according to the formula $\eta = (100\ W_{abs}^{min}/Wo)$ where $W_0$ = the power of the gamma-ray source and $W_{abs}^{min} = P_{min}vd$ ($P_{min}$ is the minimal absorbed radiation dose, v is the volume of the irradiated object, and d is the density of the irradiated object). The efficiency of all three variants for the 260-20 tire proved to be 2.8. For the 6.70-15 tire, the efficiency of the first variant was 0.7, for the second and third, 1.3. Computations showed that for the duration of vulcanization adopted (22 hours for the 260-20 tire and 19 hours for the 6.70-15 tire), it was necessary to have a radiator with a total activity of $\sim 10^6$ gram-equivalents of radium. The use of a press form of aluminum alloy with walls no thicker than 15 mm permitted the productivity of the setup (with the activity indicated) to be almost doubled. (A.I.D. Press, 2: No. 222 May 1964)

**22390** SOME APPLICATIONS OF RADIOISOTOPES IN THE FIELD OF CIVIL ENGINEERING. Akira Ariizumi (Public Works Research Inst., Tokyo). Oyo Butsuri, 32: 411-20(June 1963). (In Japanese)

Field tests, using radioisotopes as a radiation source rather than as tracers, were carried out by the Public Works Research Institute, Ministry of Construction. The moisture content of a roadbed was measured by means of a 2 mC $^{60}Co$ γ-ray source, G-M-tube penetration-type γ-ray densitometer, and $BF_3$ counter type neutron water content gage. The gages are sealed in 16 duralumin tubes (42 mm × 60 cm), and buried 20 to 45 cm under the road surface. The measurements were taken once before paving and 4 times after at every 5-cm depth for 3 min. The conversion of the counting number into the value of moisture or water content was based on a calibration curve prepared under a known specific condition. The moisture content of an old road has a minimum of about 1 $g/cm^3$ at 35 cm, while that of a new road shows a monotonic decrease with depth. Other applications cited are the measurement of 1) riverbed scouring in flood time, 2) grouting effects of the rockbed of a dam; 3) the amount of air carried along in the overflow at Futase dam; and the stratum study of seabeds by boring. (OID)

**22391** RADIOPASTEURIZATION TESTS ON PORK PRODUCTS. J. Morre and L. Richou. RTVA, Rev. Tech. Vet. Abattoirs, No. 8, 26-8(Sept.-Oct. 1962). (In French)

Radiosterilization tests were performed on pork products, using a cobalt bomb. The results showed that radiation considerably improved the bacteriological quality by destroying 60% of the microbe flora and the majority of the yeast. (P.C.H.)

**22392** INDUSTRIAL APPLICATIONS OF ATOMIC ENERGY. Jose C. Torres. Sci. Rev. (Manila), 4: 24-31 (Sept. 1963).

The applications of atomic energy in Philippine industry as a direct source of process heat, as an alternative energy source for electric power generation, as a source of intense fields of high energy radiation to cause chemical and physical changes, and for industrial research and process control are discussed. (C.E.S.)

**22393** AVTOMATICHESKII KONTROL' PLOTNOSTI ZHELEZORUDNOI PUL'PY GAMMA-LUCHAMI. (The Automatic Control of the Density of the Iron Ore Slurry by Gamma Rays). A. K. Valter, I. N. Plaksin, and M. L. Goldin. Khar'kov, Izd-vo Khar'iovskogo gos Universiteta, 1962. 244p.

Methods of enrichment of iron ore by using radioisotopes for measuring and controlling the slurry density are described. Several radioisotopes ($^{60}Co$, $^{134}Cs$, $^{137}Cs$, $^{125}Sb$, $^{133}Ba$) have satisfactory attributes for this study. Calculational methods for narrow and wide beams of radiation are given. Electronic schematics and constructions of instruments are described, and laboratory and industrial data are given. Questions dealing with the dosimetry of ionizing radiation and security measures are analyzed. The most frequently used radiometer schemes are presented. (OID)

## Power Application

**22394** EXPERIMENTS ON LIGHT SOURCE USING RADIOACTIVE KRYPTON-85 GAS. Takuya Hata and Kenzo Awazu (Mitsubishi Denki Corp., Japan). Mitsubishi Denki Lab. Rept., 5: 111-29(Jan. 1964).

Experiments carried out in the course of the trial manufacture of a self-luminescent light source using $^{85}Kr$ gas are reported. A Cu-activated zinc sulfide phosphor was used because of its high luminosity factor and high resistance to γ radiation. The specific activity of the gas was determined by mass spectrometry. Two purification methods for krypton were examined, and an absorption method by Zr powder was found to be practical. Experiments were conducted with a transmission-type lamp 20 mm in diameter. The light output efficiency was a function not only of phosphor coating density but also of phosphor particle size. In the case of ZnS:Cu of mean particle diameter 9.2μ, the maximum efficiency at its optimum coating density was 48 lm per watt. Higher efficiencies may be possible if the optimum particle size is determined. The isotope light sources are useful in the field of indicators or signals in darkness. The possibility of a brightness of 10 ft-L in both transmission-type and reflection-type lamps with windows of maximum efficiency is discussed briefly. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

## Separation and Production

**22395** EFFICIENCY FOR AN ISOTOPE SEPARATION ELEMENT AND CORRELATION BETWEEN CHANGE IN

MIXING ENTROPY AND SEPARATION POTENTIAL. O. Boettger and H. Pingel (AEG-Forschungsinstitut, Frankfurt am Main). Atomkernenergie, 9: 107-12(Mar.-Apr. 1964). (In German)

To compare various elements for isotope separation of two-component mixtures, the variation of mixing entropy caused by the separation element can be used. For isothermal processes the separation power $\delta A_m$ readily follows from the variation of mixing entropy per unit time in the separating device. If in the first approximation the separation power is divided by the product of the mole fraction N and the thermal energy $\bar{R}T$ per mole; the separation power $\delta U$ of the separation element is obtained. The separation power $\delta U$ becomes a maximum for a maximum variation of mixing entropy. The efficiency of a separation element is given by the quotient of the separation power $\delta A_m$ and the total Power $\delta A$, which the element uses for operation. Some numerical examples were calculated for the separation of uranium hexafluoride; the efficiency in these cases is of the order of $10^{-7}$ to $10^{-4}$. When using separation elements as parts of a cascade, the power consumption of a separation element is independent of the mole fraction N and the stage of the cascade, whereas the change of value described by the variation of mixing entropy depends on the concentration N. (auth)

**22396** THE PRESENT STATE AND PROBLEMS OF THE TECHNOLOGY FOR HEAVY WATER PRODUCTION. [PART] 2. Yasuo Kurihara. Genshiryoku Kogyo, 9: No. 9, 17-20(Sept. 1963). (In Japanese)

In industrial production of heavy water, the arrangement of stages and selection of processes are most important in reducing the investment and energy consumption. It is common practice to arrange processes in a series according to optimum concentration ranges. The following combinations are described briefly and discussed from the viewpoint of economy: (1) water electrolysis–water distillation–water electrolysis with partial recovery; (2) water distillation–water electrolysis with partial recovery; (3) dual temperature exchange ($H_2S-H_2O$ system)–water distillation–water electrolysis with partial recovery; (4) other combinations, including $NH_3-H_2$ exchange or hydrogen distillation processes. It is thought at the present time that the most promising process is the dual temperature exchange with the $H_2S-H_2O$ system. An industrial flow diagram based on this process and its cost estimate are given for a 3 ton/yr plant. The cost is estimated as a few tenths of a dollar per gram of $D_2O$. (Nucl. Sci. Abstracts of Japan, 3: No. 2, (Apr. 1964))

**22397** PURIFICATION OF A $^{59}Fe$ ISOTOPE PREPARATION CONTAMINATED WITH $^{60}Co$ ISOTOPE. Aladár Imre and Ernö Bujdosó (Metallurgical Research Inst., Budapest). Magy. Fiz. Folyoirat, 11: 537-41(1963). (In Hungarian)

The isotope $^{59}Fe$ is usually prepared according to the reaction $^{58}Fe(n,\gamma)^{59}Fe$ by the irradiation of $^{58}Fe$. However, the presence of Co impurity in the enriched Fe isotopic target usually results in the contamination of the product with $^{60}Co$. An extraction separation method was therefore developed in which the $^{59}Fe$ was purified in the form of an $FeCl_3$ solution. The solution was extracted with isopropyl ether saturated with 8N HCl. The organic phase was washed to eliminate traces of the contaminant. The $^{59}FeCl_3$ was reextracted with water; evaporation of the aqueous solution with dryness yielded a pure, uncontaminated $^{59}Fe$ preparation. About 95 to 97% of the original solution was reclaimed in the purified form. Control tests carried out by paper chromatography did not reveal any trace of $^{60}Co$. (TTT)

**22398** NEW METHOD FOR THE PRODUCTION OF CARRIER-FREE $^{18}F$. G. Agnes Nagy and Klára Berei. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 95-100(1964). (In Hungarian)

The $^{18}F$ isotope produced in the double nuclear reaction $^6Li(n,\alpha)T$, $^{16}O(t,n)^{18}F$ is isolated in carrier-free form by coprecipitation with calcium hydroxide and distillation. The advantage of this method over other techniques is that in less time higher yields can be obtained. The apparatus required is rather simple and it can be readily reproduced. (auth)

**22399** ISOTOPE SEPARATION BY CON-CURRENT GAS CENTRIFUGE. [PART] I. Akira Kanagawa and Yoichi Takashima (Tokyo Inst. of Tech.). Nippon Genshiryoku Gakkaishi, 6: 20-8(Jan. 1964). (In Japanese)

Both the separation factor and the separative power of a concurrent gas centrifuge were studied in relation to the gas feed rate and the effective length of the rotor. The differential equation of centrifugal separation through (n + 1) cylindrical thin concurrent streams was derived, and solved in the cases of n = 1 and 2. The relations of the gas feed rate per length of the rotor to both the separation factor and the separative power were compared with those in the case of countercurrent flow, which vary with the ratio of length of rotor to the radius. It was found that the gas feed rates in the countercurrent flows need much smaller values than the concurrent flow rates to get identical separative power, however, the gas circulating rates in the countercurrent flow are comparable. From the analysis of three cylindrical thin concurrent streams, the influence of thickness of the streams upon the separation was evaluated. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**22400** LITHIUM ISOTOPE SEPARATION ON COMPLEX FORMATION. I. EQUILIBRIUM STUDY. Shigeru Yamashita and Teruo Hayakawa (Osaka Univ.). Shitsuryo Bunseki, 11: No. 23, 106-11(Oct. 1963).

Lithium isotope separation on molecular complex formation was studied in lithium chloride–1,4-dioxane systems. The complex showed an absorption maximum at 270 mμ, and the molar ratio LiCl/dioxane in the complex was found to be 1:1. The isotope ratio was determined by a mass spectrometer using a surface-ionization ion source. The results showed that Li is enriched in the complex, and the single-stage separation factor is 1.026 in equilibrium at 100°C. The separation of lithium isotopes seemed to occur during the isotope exchange reaction between LiCl-dioxane complex and uncomplexed LiCl. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**22401** PROBLEMS IN THICK TARGET IRRADIATION IN CYCLOTRONS. P. Strohal (Inst. "Ruder Boskovic," Zagreb). Tehnika (Belgrade), 18: 234-5(Feb. 1963). (In Serbo-Croatian)

Irradiation problems for thick targets in the internal cyclotron beam are described. The type of nuclear reaction which leads to a certain radionuclide, the change in the cross section values with the variations of the energy of incident particles, the energy loss of the incident particles when passing through the target material, the melting point and vapor pressure of the target material, and the possibility of decomposition of the target material are important factors discussed in cyclotron radionuclide production. Optimizing the various factors effecting the target preparation of metal alloys or chemical compounds is discussed. Cyclotron target holders are mentioned for several functions. (OID)

**22402** SEPARATION OF RADIOACTIVE ISOTOPES WITHOUT REMOVING THE EXTRACTING ORGANIC SOLVENT. N. P. Rudenko. Tr. Komis. po Analit. Khim., Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim., 14: 11-23 (1963). (In Russian)

The advantages of solvent extraction for the concentration of radioactive isotopes are outlined. It is noted that specific conditions of extraction are rigidly required in a number of cases. More than 59 chemical elements can be separated by solvent extraction. It is pointed out as an example of simplicity of the solvent extraction method that cadmium can be recovered from a fission product mixture with a 77% yield by a dithizone extraction from a tartrate solution at a pH of 13. The decontamination coefficient varies from 10 (for zinc and thallium) to $10^4$ (for cerium, cobalt and other elements). A chromatographic separation gave a lower yield of 62% and required more time. Precipitation of cadmium with thiourea gave a lower yield of 48%, and the cadmium product was not carrier-free. A total of 17 steps are required to obtain cadmium with a decontamination coefficient of $3 \times 10^6$. The repetition of a number of steps in solvent extraction is a simple matter. Because of the number of chelating agents available, it is possible to create specific conditions for the extraction of a radioactive isotope. Poskanzer and Foreman in J. Inorg. Nucl. Chem. 16: 323 (1961) give $pH_{50}$ values (pH value at which 50% of an element is extracted) for solvent extraction of a large number of elements with a 0.2M TTA (2-thenoyltrifluoroacetone) solution. Extractions by means of 8-oxyquinoline, acetylacetone, benzoylacetone, and dibenzoylmethane show lower extraction coefficients than extractions by the corresponding dibromide derivatives. Solvent extraction by these compounds is discussed. The synergistic effect of an added solvent is noted and discussed. (TTT)

**22403** SEPARATION OF ISOTOPES BY $UF_6$ SUBLIMATION. French Patent 1,335,830. Aug. 23, 1963. Filed Oct. 9, 1962.

**22404** CONCENTRATION OF HEAVY WATER BY THE USE OF LIQUID ION EXCHANGES. H. Kakihana (to Mitsubishi Chemical Industries Co., Ltd.). Japanese Patent 19,101. Sept. 21, 1963.

**22405** CONCENTRATION OF HEAVY WATER BY THE USE OF INORGANIC ION EXCHANGERS. H. Kakihana (to Mitsubishi Chemical Industries Co., Ltd.). Japanese Patent 19,102. [1963].

**22406** CONCENTRATION OF HEAVY WATER FROM CONCENTRATED SALINE SOLUTION. T wabe, T. Noguchi, and H. Kakihana (to Akaho Saline Water Industry Co., Ltd.). Japanese Patent 19,252. Sept. 23, 1963.

# MATHEMATICS AND COMPUTERS

*Refer also to abstract 21932.*

**22407** (CERN-64-18) STATISTICS LECTURES II: MAXIMUM LIKELIHOOD AND LEAST SQUARES THEORY. Derek J. Hudson (European Organization for Nuclear Research, Geneva). Apr. 8, 1964. 113p.

A problem in hypothesis testing is solved by using the t distribution; probability paper is used to test for a normal distribution; the F distribution is defined and its density function is derived. The principle of maximum likelihood is introduced from the intuitive point of view of trying to find the most likely explanation of the experimental data observed. The graphs of several likelihood functions are sketched, most of them on a logarithmic scale. Bayes theorem shows how the likelihood function should be modified when prior information about the parameters is available. The section on least squares deals with the problem of fitting a polynomial to data pairs $(x_i,y_i)$, where the $\{x_i\}$ are fixed in advance and the $\{y_i\}$ are random variables. Matrix algebra is used extensively to derive classical results, including the Gauss-Markoff theorem. Orthogonal polynomials are used both to simplify the analysis and to control rounding errors in the actual computations. The F test is used to help choose the degree of the polynomial to be fitted, when this is unknown. (auth)

**22408** (KAPL-M-6116) BKSK—A REVISION OF THE BKS SYSTEM FOR THE PHILCO-2000 COMPUTER. C. H. Hunter and E. E. Kazmierczak (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 12, 1964. Contract W-31-109-eng-52. 100p.

The program BKSK, a two-phase computer program, automatically sequences a set of independent jobs on the Philco 2000. The program restrictions, modifications, and operation are discussed. (D.C.W.)

**22409** (LA-3043) AN INTEGRATED SERIES OF CRYSTALLOGRAPHIC COMPUTER PROGRAMS. II. PROCESSING COLLECTED INTENSITY DATA. Allen C. Larson, Don T. Cromer, and R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). Jan. 1964. Contract W-7405-eng-36. 61p.

The procedures employed and the computer program used for the processing of intensity data collected on a single crystal orienter are described. Processing includes the correction of the data for Lorentz-polarization, absorption, background, and crystal-shape effects and yields a nonscaled set of relative $F^2$. (auth)

**22410** (UCRL-11184(p.141-9)) SOME METRIC PROPERTIES OF THE SYSTEMS OF COMPARTMENTS. Aldo Rescigno and Giorgio Segre (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkeley. Lawrence Radiation Lab.).

Rules for the enumeration of the strong components of a graph and for the calculation of its variable adjacency matrix are presented. A new method is given, to calculate the transfer function of a graph, by analyzing the strong components of the graph, the elementary paths between two nodes, and the linear subgraphs. (auth)

# METALS, CERAMICS, AND OTHER MATERIALS

## General

**22411** (AD-417692) THE DEVELOPMENT OF OPTIMUM MANUFACTURING METHODS FOR COLUMBIUM ALLOY SHEET. ITEM 1: SUB-CONTRACT FOR THE DEVELOPMENT OF SHEET PROCESS FOR D-43 ALLOY. Interim Report No. IX, December 15, 1962–July 15, 1963. A. L. Mincher (Du Pont de Nemours (E. I.) & Co. Metals Center, Baltimore). Contract AF33(600)-39942. 62p.

Two 8-in.-dia ingots of D-43 alloy (previously designated X-110) were processed to 24-in. wide sheet panels in three gages, 0.012, 0.018, and 0.030 inches. Details of sheet conversion and evaluation of properties are reported. (auth)

**22412** (AD-422106) STUDIES OF REFRACTORY ALLOY SHEET MATERIALS. Quarterly Report, June 15–September 15, 1963. Robert Q. Barr, Paul R. Pfefferle, and M. Semchyshen (Climax Molybdenum Co. of Michigan, Detroit). Contract NOw-62-0419-c. 13p. (N64-12377)

The following alloys were consolidated by the vacuum-arc-casting technique, and converted to 0.05-in.-thick sheet: Mo + 1.59% Nb + 0.52% Ti + 0.21% Zr + 0.068% C, Mo + 1.30% Ti + 0.35% Zr + 0.093% C, and W + 3.10% Mo + 0.04% Zr + 0.001% C. The two molybdenum-base alloys were either recrystallized, solution treated, or solution treated and aged prior to rolling. The tungsten-base alloy was in the recrystallized condition prior to rolling to final size. (auth)

**22413** (AD-426848) EFFECTS OF THERMO-MECHANICAL VARIABLES ON THE TEXTURE AND BEND DUCTILITY OF HIGH-PURITY BERYLLIUM SHEET. Interim Report, July 15–December 15, 1963. (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract AF33(657)-11234. 8p. (I-B2106-1)

Progress is reported on an investigation to determine the effects on beryllium sheet properties (texture, bend, ductility, and strength) of the use of high purity material and deformation procedures which minimize basal plane texturing. The material chosen was the highest purity powder available commercially in reasonable quantities (SR Pechiney). The deformation procedures chosen are hot upsetting, hot forging, and compression rolling. The objective is to attain beryllium sheet with good bend ductility combined with useful strength properties by means of heat treatment, the control of basal plane texture; and the use of high purity and fine grain size material. (auth)

**22414** (ASD-TR-7-756(X)) MOLYBDENUM FORGING PROCESS DEVELOPMENT. Interim Technical Progress Report No. 10, June 15, 1963 to September 15, 1963. A. W. Goldenstein (Westinghouse Electric Corp., Blairsville, Penna.). Contract AF33(600)-41419. 48p. (AD-418986)

A reproducible process for making thin-sectioned TZM forgings was developed and a pilot lot of twenty forgings produced. Web and rib sections were held to a 0.13 in. maximum and surface generally was better than 125 RMS. Uniformity of structure and properties verified process reproducibility. (auth)

**22415** (BMI-X-10082) DEVELOPMENT OF NIOBIUM-BASE ALLOYS FOR USE IN A NUCLEAR SUPERHEATER. Quarterly Progress Report, January–March 1964. Robert D. Koester, John A. DeMastry, Warren E. Berry, Arthur A. Bauer, and Frank A. Rough (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 7p. (EURAEC-1032)

Niobium-base alloys resistant to 540 and 650°C steam are evaluated. Chromium, titanium, and vanadium in combinations were found to improve the corrosion resistance while iron, molybdenum, and zirconium additions were detrimental. A Nb-21 at. % Ti-12 at. % V-9 at. % Cr alloy exhibits a weight gain of only 371 mg/dm$^2$ after 329 days exposure to 540°C steam at 1500 psi. After 105 days, Nb-24 at. % Ti-12 at. % V-12 at. % Cr alloy did not exhibit surface cracking at 650°C – 1500 psi steam exposure, and it was covered with a gray oxide coating. It exhibits a weight gain of 962 mg/dm$^2$. Fabrication of larger ingots of Nb-21 at. % Ti-12 at. % V-9 at. % Cr, Nb-21 at. % Ti-18 at. % V-12 at. % Cr, and Nb-18 at. % Ti-15 at. % V-12 at. % Cr was attempted. All three alloys were successfully extruded at 1480°C. Subsequent cold and warm rolling of the extruded rods was successful only for the Nb-21 at. % Ti-12 at. % V-9 at. % Cr alloy. (N.W.R.)

**22416** (CONF-281-44) HISTORY, OBJECTIVES, AND STATUS OF U.S.A.E.C. BeO PROGRAM. Jack G. Conner (Division of Reactor Development, AEC). [196?]. 22p.

From International Conference on Beryllium Oxides, Sydney, Oct. 1963.

Studies of BeO as a moderator and as a fuel matrix material are discussed. Individual research programs are described. (M.C.G.)

**22417** (CONF-281-46) GROWTH AND PROPERTIES OF BERYLLIUM OXIDE SINGLE CRYSTALS. S. B. Austerman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [1963]. Contract AT(11-1)-Gen-8. 32p.

From International Conference on Beryllium Oxides, Sydney, Oct. 1963.

The growth of beryllium oxide single crystals from a molten flux of $Li_2MoO_4$–$MoO_3$ by a steady-state thermal gradient is described. The combined influence of flux composition, temperature, temperature gradient, and flux impurities can be used to control nucleation and growth of a wide variety of crystal habits. Characteristics and mechanisms of crystal growth, as observed, as well as some properties of the single crystals, are also described. (auth)

**22418** (IITRI-B6021-1) VANADIUM ALLOY STUDIES. Bimonthly Report No. 1, February 1, 1964–March 31, 1964. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Apr. 16, 1964. Contract NOw-64-0239-c. 16p.

Vanadium development studies described herein have the primary objective of producing improved short-time (15-min to at least 1-hr) creep and stress-rupture properties at temperatures in the 2000 to 2400°F range. Initial work involves the determination of short-time creep behavior of certain promising compositions in vacuum at 2200°F. The effect of tantalum, tungsten, and molybdenum additions on creep of V-60Nb-1Ti is being determined. Reinvestigation of certain binary systems, notably V–Ta, is being carried out with the hope of formulating beneficial heat treatments for enhancement of high-temperature properties. (auth)

**22419** (TID-20589) MATERIALS FOR HIGH-TEMPERATURE NUCLEAR ENGINEERING APPLICATIONS. Quarterly Report No. 6, October 1, 1963–January 1, 1964. J. D. Fleming, J. W. Johnson, Paul Boland, and S. H. Bomar (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-2483. 16p.

Brief determinations were made of the physical properties of two types of foam prepared from fused silica slip. Efforts to measure reaction kinetics in Al–$U_3O_8$ dispersions were continued. A new dispersion was found to undergo catastrophic swelling at elevated temperatures, causing loss of beam alignment in the dynamic x-ray system. This dispersion was replaced. The problem was solved by inverting the x-ray furnace, supporting the specimen on the fuel meat side upon a stainless steel grid, and carrying out diffraction from below the horizontal axis of the goniometer. A new replication technique was developed which permits location of specific areas in ATR dispersions for electron micrography. The technique consists of producing a polyvinyl alcohol replica from which a secondary nitrocellulose replica is formed and stripped. The nitrocellulose replica is shadowed with platinum and coated with carbon. After dissolution of the nitrocellulose in amyl acetate or acetone, the carbon-platinum replica is left intact instead of fragmented as is usually the case. The replica can be indexed with the sample and areas observed optically on the sample or the polyvinyl alcohol replica can be located quickly on the carbon-platinum replica in the electron microscope. The polyvinyl alcohol replica is not destroyed in the process and can be used to produce a series of carbon-platinum replicas if desired. (auth)

**22420** (USBM-U-1109) QUARTERLY METALLURGICAL PROGRESS REPORT NO. 22 FOR THE PERIOD OF JANUARY 1–MARCH 31, 1964. (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Contract AT(11-1)-599. 29p.

Five sections are abstracted separately and two sections are included in this abstract. The installation and use of the equipment for differential thermal analysis, heat treating, and metallographic examination are the areas of primary endeavor in the phase studies of thorium–holmium, thorium–neodymium, and thorium–praseodymium alloys. Studies of induction melting in a cold crucible are presently centered about the development of an integral assembly of a field intensifier and a cooled crucible. A new installation for future experiments is also being prepared. (N.W.R.)

*For abstracts of individual sections see: 22207, 22421, 22422, 22423, and 22496.*

**22421** (USBM-U-1109(p.3-4)) RARE EARTH ALLOY DEVELOPMENT. (Bureau of Mines. Albany Metallurgy Research Center, Ore.).

The work consisted of determining phase relationships in the 10 wt % gadolinium isopleth of the iron–chromium–gadolinium system for alloys containing up to 50 wt % chromium and studying plastic workability of iron–chromium–gadolinium alloys containing 12 to 30 wt % chromium and up to 6 wt % gadolinium. (auth)

**22422** (USBM-U-1109(p.11-15)) INVESTIGATION OF THE SYSTEM URANIUM CARBIDE–URANIUM NITRIDE–URANIUM OXIDE. (Bureau of Mines. Albany Metallurgy Research Center, Ore.).

Considerable progress was made in the development of techniques for handling the pyrophoric powders and bodies and in the high temperature sintering, decomposition pressure measurement, and body evaluation. Preliminary examination of compositions of the three binary systems UC–UN, UC–UO and UN–UO were conducted. (auth)

**22423** (USBM-U-1109(p.19-24)) TUNGSTEN–RHENIUM TUBING DEVELOPMENT. (Bureau of Mines. Albany Metallurgy Research Center, Ore.).

Methods were developed to fabricate satisfactory consumable electrodes of tungsten-25 wt % rhenium alloy. Equipment modification was completed for small-scale melting and skull-casting of the alloy. Both ingots and skull-castings were produced. The preparation of sintered tungsten-25 rhenium sleeves was continued by tumble-mixing, screen blending through 100-mesh screens, isostatic pressing, presintering in hydrogen at 1,500°C, and sintering in vacuum at 2,400 to 3,000°C. Alternate methods for supporting the sleeves were devised to minimize warpage. Results obtained indicated that concentricity is best maintained by supporting the sleeves on coarse powder during sintering; flaring of the bottom end of the sleeves is minimized when the sleeves are surrounded by coarse powder. Small alloy sleeves which were sintered at 2,400 or 3,000°C were swaged at 1,500°C over a molybdenum mandrel to reduce the overall diameter by 25% then annealed to obtain recrystallization. The resulting densities of the sleeves were 19.28 and 19.46 g/cc as compared to a theoretical density of 19.62. Six sleeves that were sintered in hydrogen for 15 hours at 2,400°C were swaged at 1,500°C over a molybdenum mandrel to reduce the overall diameter by 15, 18, 27, and 56 percent. Those swaged to reduce the diameter by 15% were sound, but surface cracking was noted for greater reductions, the number and severity of cracks increasing with increasing reductions. Tensile properties of alloy sheet were obtained in the temperature range where drawing is contemplated. The results showed that the ductile-brittle transition in tension is between 300 and 400°C, and that for tests made at 400 and 600°C, the elongation values decreased from 10 to 8%, and the yield strength decreased by 13%. Two unsuccessful attempts were made to draw commercial alloy tubing at 450 and 575°C over molybdenum mandrels. The tubing failed by cracking at 450°C, and the tubing could not be satisfactorily gripped at 575°C due to the high hardness of the alloy and the relatively high operating temperature for the tool steel grips. (auth)

**22424** (WAL-TR-401/303-2) DEVELOPMENT OF TOUGH, HIGH-STRENGTH ALPHA-BETA TITANIUM-BASE ALLOYS AT 240,000-260,000 PSI YIELD STRENGTH LEVEL. Quarterly Progress Report No. 3, December 26, 1962–March 25, 1963. P. A. Farrar and H. Margolin (New York Univ., New York. Coll. of Engineering). Contract DA-30-069-ORD-3690. 41p. (AD-417472)

In order to develop titanium alloys with 0.1% yield strength in the range 240,000–260,000 psi, a series of alloys are being prepared at two interstitial levels. Beta transus temperatures were determined for 30 alloys on 25-gram ingots. Melting and forging of eight-pound ingots were completed and machining, heat treating, and testing of tensile and impact specimens are in progress. Heat treatment and testing of specimens were completed for seventeen alloys and the data are included. (auth)

**22425** (WANL-PR-M-005) PILOT PRODUCTION AND EVALUATION OF TANTALUM ALLOY SHEET. Quarterly Report No. 4, February 15–May 15, 1963. R. L. Ammon and R. T. Begley (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Aug. 15, 1963. Contract N600 (19)59762. 18p.

Melting and conversion of two ingots of Ta–9.6 wt % W–2.4 wt % Hf–0.01 wt % C (T-222) alloy are described. Preliminary data indicate that T-222 sheet has excellent high temperature strength (53,000 psi) and 24,900 psi ultimate tensile strength at 2400 and 3000°C, respectively. This alloy exhibits excellent cold rolling characteristics

and good weldability. TIG welds are fully ductile at –250°F over a 2.5T bend radius. (N.W.R.)

**22426** (WANL-PR(P)-002) DETERMINATION OF THE WELDABILITY AND ELEVATED TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS. Quarterly Report No. 2, September 21–December 21, 1963. G. G. Lessmann and D. R. Stoner (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Contract NAS-3-2540. 50p.

Procurement of the refractory alloys and metals is being accomplished. The welding chamber atmosphere monitoring system was completed and placed into regular operation. Weld chamber tooling is being installed. The electron beam welder was modified by the addition of a liquid nitrogen trap to improve vacuum capability following initial testing. Welding studies were initiated by producing weld restraint bead-on-plate patch tests in sheet from five alloys (Ta-10W, D-43, Nb-752, SNb-291, and C-129Y) and a circular groove restraint weld test in Ta-10W plate. In addition a weld joint configuration evaluation was undertaken for the $\frac{3}{8}$ inch plate thickness being evaluated in this study. (N.W.R.)

**22427** (WANL-PR(Q)-002) DEVELOPMENT OF DISPERSION-STRENGTHENED TANTALUM-BASE ALLOY. Quarterly Progress Report No. 2, September 20–December 19, 1963. R. W. Buckman, Jr. and R. T. Begley (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Contract NAS-3-2542. 38p.

The preparation, fabrication, and properties of tantalum–tungsten–hafnium alloys with additions of carbon or zirconium are evaluated. Eight hundred gram nonconsumable arc melted ingots are prepared to establish composition limits commensurate with adequate fabricability, and to define the effects of solute and interstitial additions on properties. Detailed mechanical property and weldability evaluations are being conducted on sheet processed from two-inch diameter double vacuum arc melted ingots weighing ten pounds. Data are presented on forging, carbon contents, compositions, hardness, microstructure, rolling, and casting. (N.W.R.)

**22428** (EURAEC-838) RESULTS OF WORK CARRIED OUT FROM JULY 1 TO SEPTEMBER 30, 1963. Quarterly Report No. 6. (Compagnie Pechiney, Paris). Oct. 31, 1963. Work performed under United States–Euratom Joint Research and Development Program. Contract 067-62-4RDF. 20p. (A translation)

A comparison is made between Zircaloy-2 and zirconium–tin alloys containing vanadium, nickel, and titanium with respect to corrosion by steam at 350, 400, and 480°C and tensile properties. Techniques used in extrusion of the alloys are discussed. (N.W.R.)

**22429** (TRG-Inf-Ser-382) THE ELECTRON MICROPROBE—APPLICATIONS IN METALLURGY. V. Leroy and L. Habraken. Translated by W. Batey (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England), from Rev. Universelle Mines, 19: 45-62(Feb. 1963). 27p.

A general description is given of the working principles of the electron microprobe and the physical basis of quantitative point analysis. The possible uses of the instrument are considered, in particular for the determination of very light elements. The automatic "scanner" is described. Examples of research are presented to demonstrate certain applications with the microprobe. These include: studies on the boundary between geology and metallurgy, problems in metal refining, studies on dendritic segregation and banded structure, studies on atomic diffusion, and studies on alloy corrosion. (auth)

**22430** PRODUCTION OF URANIUM CARBIDE FUEL ELEMENTS. John H. Meyer (American Anaconda Brass Co., Waterbury, Conn.). Can. Nucl. Technol., 3: 60-3 (1964).

The production and uses of uranium monocarbide reactor fuels are discussed. Arc melting and casting and electron-beam melting are discussed. Some properties of UC, $U_2C_3$, and $UC_2$ are compared. (R.E.U.)

**22431** ALUMINOTHERMIC REDUCTION OF LANTHANUM, CERIUM, AND PRASEODYMIUM OXIDES. V. A. Podvergin and G. V. Samsonov. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo, No. 5, 50-7(Sept.-Oct. 1963).

A study was made of the conditions for preparing alloys of lanthanum, cerium, and praseodymium with aluminum by aluminothermic reduction of the oxides. It was shown that this process can be used to obtain alloys containing up to 30–50% rare earth metals. The maximum lanthanum content of alloys was 27.65%, with a yield in the alloy of 18.7%. Yields of cerium and praseodymium under optimum reduction conditions reached 32.0 and 28.0%, respectively. The effect of particle size of the aluminum powder, reaction rate, crucible shape, and characteristics of that input on the yield and content of rare earth metals in the alloy was established. At high thermal inputs, (>1100 kcal/kg), the charge burns rapidly. A charge containing aluminum powder with a particle size of 0.053 mm and smaller reacts with particular vigor, but the content of rare earth metals in the alloy decreases. Melting with aluminum powder of 0.105 mm particle size proceeds satisfactorily at moderate heat inputs. The optimum heat input for a charge containing aluminum powder of 0.105 mm particle size is 850 kcal/kg for the reduction of lanthanum and cerium oxides, and 800 kcal/kg for praseodymium oxide. (OTS)

**22432** THE LABORATORY PREPARATION OF ACTINIDE ELEMENTS OF THE 50g SCALE. J. A. S. Mowat (United Kingdom Atomic Energy Authority, Thurso, Caithness, Eng.) and W. D. Yuille. J. Less-Common Metals, 6: 295-8(Apr. 1964).

The preparation of uranium, plutonium, and neptunium on the 50g scale is described. Tetrafluorides of the metals were mixed with appropriate quantities of pure calcium in crucibles of calcium fluoride, and reaction was initiated by heating the charge in an argon-filled steel container. Yields of metal were of the order 95–98% of theoretical, and the product densities were little less than the corresponding x-ray densities. Thermodynamics of the reactions are briefly discussed. (auth)

**22433** METHOD FOR THE PREPARATION OF ALLOYS OF ALUMINUM AND METALS OF ACTINIDES. Raymond Hugh Moore (to U. S. Atomic Energy Commission). German Patent 1,160,193. Dec. 27, 1963. Priority date Mar. 21, 1961, United States.

A method described for the preparation of alloys of aluminum and metals of actinides, e.g., aluminum–thorium, aluminum–uranium, or aluminum–plutonium comprises the steps of resolving the oxides of actinides or a chloridizable material of actinides in a molten chloride of actinides, of adding a chlorinating agent and aluminum to the melt, and of circulating oxygen-containing gas through the reaction mass so that the metal of actinides is formed and alloyed with aluminum. (Gmelin Inst.)

**22434** ZIRCONIUM ALLOY. R. Elwyn Johnson and William Dale McMullen (to U. S. Atomic Energy Commission). German Patent 1,160,636. Jan. 2, 1964. Priority date Feb. 26, 1960, United States.

A zirconium alloy of high strength and good corrosion

resistance is described that is composed of 3 to 10% aluminum, 0.1 to 4% molybdenum, 0.05 to 1% beryllium, eventually up to 1% boron, and the remainder zirconium. (Gmelin Inst.)

**22435** DIRECT HEATING OF CELLS FOR THE PRODUCTION OF TITANIUM, ZIRCONIUM, THORIUM OR URANIUM BY FUSION ELECTROLYSIS. Hans-Juergen (to Deutsche Gold- und Siber-Scheideanstalt). German Patent 1,160,646. Jan. 2, 1964. Filed Sept. 13, 1958.

A graphite body is immersed into the melt which functions as heating element as well as electrode. (Gmelin Inst.)

**22436** FUSION ELECTROLYSIS FOR THE CONCENTRATION OF URANIUM AND/OR PLUTONIUM IN ALUMINUM ALLOYS. W. Earl Roake and W. Lewis Lyon (to U. S. Atomic Energy Commission). German Patent 1,160,647. Jan. 2, 1964. Priority date June 24, 1958, United States.

The method comprises the steps of electrolyzing the neutron-irradiated aluminum–uranium alloy using a molten electrolyte which contains cryolite. The alloy in which the fission products are concentrated is obtained. The liquid alloy, which is contained in a porous graphite crucible immersed into the molten electrolyte, is also the anode. The cathode material can be graphite or liquid aluminum. (Gmelin Inst.)

**22437** MANUFACTURE OF SINTERED URANIUM DIOXIDE. Alain Bel, Roger Delmas, and Bernard Francois (to Commissariat a l'Energie Atomique). U. S. Patent 3,129,055. Apr. 14, 1964. Priority date Apr. 28, 1959, France.

Sintered uranium dioxide of high density and stoichiometric composition may be prepared from ammonium uranate by the following steps: calcination at 350 to 450°C for 5 to 20 hr; reduction in a dry cracked ammonia atmosphere in two temperature stages, the first at 350 to 450°C and the second at 600 to 700°C; reoxidation in the cold in an oxygen-containing nitrogen current; incorporation of a molding additive; a first compression followed by crushing and screening; a second compression under pressure of 2.5 to 5 tons/cm$^2$; removal of the molding additive in vacuo; and sintering in a dry cracked ammonia atmosphere for 5 hr at 1250 to 1400°C. (A.G.W.)

## Corrosion

**22438** (CONF-281-45) TECHNIQUES FOR MEASURING LOCALIZED CORROSION RATES OF BERYLLIUM OXIDE. J. B. Conway, D. G. Salyards, J. Holowach, and R. A. Stanley (General Electric Co. Advanced Technology Services, Cincinnati). [1959]. Contract AT(40-1)-2847. 23p.

From International Conference on Beryllium Oxides, Sydney, Oct. 1963.

Three techniques are described which allow the measurement of localized corrosion rates of beryllium oxide in moist atmospheres. These techniques were applied in the evaluation of the corrosion rates of beryllia tested in air containing 0.76 wt % water vapor. The experimental results in the range of 980 to 1425°C showed fairly good agreement with theoretical values obtained from proposed analytical expressions. (auth)

**22439** (EURAEC-1000) THE PERMEABILITY OF ZIRCONIUM SURFACE FILMS TO HYDROGEN. P. Gondi, G. Missiroli, and T. Visani (Bologna. Università. Istituto di Fisica "A. Righi."). [nd]. Work performed under United States–Euratom Joint Research and Development Program. 13p.

Relations are presented that express the dependence of the absorption rate times the film thickness versus the temperature and the pressure. The structural effects of zirconium oxide films on hydrogen diffusion were determined. Three different types of diffusion, in crystal boundaries, in sub-crystal boundaries, and in the bulk of the oxide, were postulated. Results are shown in graphs. (M.C.G.)

**22440** (HW-77529) EFFECT OF OXIDE DISSOLUTION AND HEAT TRANSFER ON THE CORROSION OF ALUMINUM FUEL CLADDING. D. R. Dickinson and R. J. Lobsinger (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1963. Contract AT (45-1)-1350. 21p.

In-reactor corrosion rates of aluminum-clad fuel elements in high-temperature deionized water were much higher than measured in isothermal out-of-reactor tests at the same pH and surface temperature. This discrepancy is explained in terms of oxide dissolution and heat transfer. In a nonisothermal in-reactor system, the temperature, and hence the solubility, of aluminum oxide corrosion product, is greater at the fuel-element surface than at the cooler portions of the primary loop. This results in significant dissolution of the protective aluminum oxide from the fuel element and a large increase in its corrosion rate. There was good agreement between calculated dissolution rates and measured corrosion rates. In addition to promoting dissolution, heat transfer also raised the cladding temperature and corrosion rate because of the temperature drop across the surface oxide film. Measurements of cladding temperature showed particularly high temperature drops in in-reactor tests at reduced pH where a heavy layer of crud (deposited iron oxides) was present on the fuel surface. (auth)

**22441** (HW-79048) DESCALING OF VARIOUS IRON- AND NICKEL-BASE ALLOYS. H. P. Maffei (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1963. Contract AT(45-1)-1350. 21p.

Descaling various iron and nickel base alloys oxidized in 550°C steam using a molten 60% NaOH–40% $Na_2CO_3$ bath was investigated. Some observations on the selection of current densities are described, and the application of the molten salt descaling process to irradiated samples was considered. The results showed that the molten electrolytic NaOH–$Na_2CO_3$ descaling bath worked equally well on nickel and iron base alloys if an appropriate current density is used. For nickel base alloys 75 amp/dm$^2$ current density was satisfactory; for austenitic stainless steels 25 amp/dm$^2$; and for ferritic stainless steels and Fe–Cr–Al alloys 15 amp/dm$^2$. Metallographic cross section of the various autoclaved iron and nickel base alloys before and after descaling showed that except for AISI 304L SS samples there was no intergranular attack by the descaling bath. Data are tabulated. (P.C.H.)

**22442** (KAPL-M-6102) THE EFFECT OF MEDIA ON THE CORROSION RESISTANCE OF ZIRCALOY-2. A. M. Andrako (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 20, 1963. Contract W-31-109-eng-52. 34p.

Zircaloy-2 samples were exposed in static and tilting autoclaves to various concentrations of ammonia hydroxide and lithium hydroxide. The work shows that LiOH concentrations in excess of pH-12 can cause severe corrosion of Zircaloy-2. In lithiated coolants, high concentrations of LiOH can occur on Zircaloy surfaces when these surfaces are alternately exposed to high temperature water

and steam. Crevice areas, where high concentration of LiOH generally occur, are particularly susceptible to accelerated attack. A three-day precorrosion film offers little protection to Zircaloy-2 materials in high concentrations of LiOH. Corrosion attack is much less severe in $NH_4OH$ media, even in extreme conditions. (auth)

**22443** (LAMS-3063) GRAPHITE CORROSION STUDIES FOR THE ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT. P. G. Salgado (Los Alamos Scientific Lab., N. Mex.). Mar. 25, 1964. Contract W-7405-eng-36. 40p.

Experiments were conducted to study graphite corrosion in an atmosphere of helium containing low concentrations of carbon dioxide (0 to 70 ppm). The test loop, operating at 500 psig with a maximum gas temperature of 2400°C for 30 days, performed well for four tests. The extent of graphite corrosion in described approximately by Rate = $1.0 \times 10^{-2}$ C where Rate is the loss in weight in milligrams per square centimeter per hour and C is the concentration of carbon dioxide in ppm by volume. The test loop and experimental procedures are described and the results obtained are discussed. (auth)

**22444** (MSAR-63-126) FACTORS AFFECTING THE COMPATIBILITY OF LIQUID CESIUM WITH CONTAINMENT METALS. Quarterly Progress Report No. 4, June–August 1963. F. Tepper and J. Greer (MSA Research Corp., Callery, Penna.). Sept. 13, 1963. Contract AF33 (657)-9168. 9p. (AD-417675)

Work is continuing on investigation of mechanisms associated with the attack of liquid cesium on Haynes-25, niobium–1% zirconium, and molybdenum–½% titanium. Preliminary evaluations were performed on the compatibility of TD Nickel, a dispersion alloy, with liquid cesium. Dissimilar metal capsules of Haynes-25 vs Nb–1Zr and Nb–1Zr vs Mo–½Ti were heated in a cesium environmen at 1800 and 2500°F, respectively. Solubility studies of the alloys in liquid cesium are underway, utilizing refractory metal crucibles for sampling at temperature. A device for determination of the solubility of carbon in cesium is in the design stage. (auth)

**22445** (MSAR-64-45) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report No. 43, March 1964. (MSA Research Corp., Callery, Penna.). Apr. 27, 1964. Contract AT(11-1)-765. 11p.

The effects of air, helium, and sodium on the mechanical properties of chromium-molybdenum steel and type 316 stainless steel are evaluated. The effects of carbon and oxygen contaminants in the systems are investigated. (N.W.R.)

**22446** (ORNL-3591(p.77-83)) MECHANISMS OF CORROSION OF ZIRCONIUM ALLOYS. G. H. Jenks (Oak Ridge National Lab., Tenn.).

Studies of zirconium and Zircaloy-2 in high-temperature solutions used a revised autoclave system in which simultaneous measurements of the d-c capacitance and polarization of the electrode can be made. The results of these measurements demonstrated that the products of the corrosion enter quantitatively into formation of the protective film according to the logarithmic relationship, and that the dielectric properties of the oxide are approximately constant during the period investigated. It was also found that the capacitance was unaffected by the addition of $Cu^{2+}$ as $CuSO_4$ to $[Cu^{2+}] = 6.5 \times 10^{-2}$M. The open-circuit potential increased anodically by 300 mv, demonstrating that $Cu^{2+}$ is an oxidizing agent whose rate of reduction is comparable to that for $O_2$. Results previously obtained at long exposure times were confirmed. The results are consistent with the anion-vacancy mechanism for zirconium corrosion. The mechanism of radiation corrosion of Zircaloy-2 is being studied by comparing the weight gain and film impedance behavior of irradiated specimens with unirradiated controls during postirradiation exposure to steam-oxygen mixtures at 300°C. Film-free, as-pickled, and prefilmed specimens were irradiated. Experimental results obtained so far provide evidence that changes produced within the alloy during irradiation lead to acceleration of corrosion. No significant effects of the irradiation on the protective properties of the oxide film were detected. (auth)

**22447** (SB-401(Suppl.1)) CORROSION. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Sept. 1963. 61p.

Approximately 940 references on corrosion resistant coatings, corrosion resistant alloys, corrosion inhibitors and inhibition, stress corrosion, and rust prevention and removal are given to U. S. and foreign journals and reports published from 1950 through 1962. (P.C.H.)

**22448** (UCRL-10890) STACKING FAULT ENERGY, ORDERING AND TRANSGRANULAR STRESS CORROSION CRACKING IN Fe–Cr–Ni ALLOYS (thesis). Walter Ray Roser (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1963. Contract W-7405-eng-48. 44p.

The electron microscope was used to measure stacking fault energy of several iron–chromium–nickel alloys and to determine the dislocation structure after plastic deformation. It was found that additions of nickel increase the apparent stacking fault energy, and niobium in solid solution decreases the apparent stacking fault energy. Dislocations were found to remain coplanar even though from the stacking fault energy consideration, they would be expected to cross-slip and form tangles. It is proposed that the apparent increase in stacking fault energy with increasing nickel is due to the promotion of ordering in the lattice by the nickel. With this assumption, it is possible to explain the coplanar dislocation arrays in alloys with high stacking fault energies. It is further proposed that transgranular stress corrosion arises from the fact that order is destroyed locally across the slip plane by plastic deformation. Utilizing this model for transgranular stress corrosion cracking, it is possible to explain the transition from intergranular to transgranular stress corrosion cracking observed in alpha brasses. (auth)

**22449** ON THE KINETICS OF OXIDATION OF MAGNESIUM ALLOYS CONTAINING 0.15 AND 0.4% Zr IN DAMP OXYGEN AT HIGH TEMPERATURES. Raymond Darras, Jean Paiedassi, and Francis Leroy (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 258: 2999-3002(Mar. 16, 1964). (In French)

The oxidation of the two alloys in damp oxygen was studied at 400 to 600°C and compared with that of nonalloyed Mg. Initially, the alloys oxidize more slowly than the metal, especially between 400 and 500°C. For the 0.15% Zr alloy, the law of oxidation is always linear; the 0.4% Zr alloy passes through a parabolic regime to a linear regime at higher temperatures. When the linear regime is established, the speeds of oxidation are much nearer that of Mg. (D.C.W.)

**22450** CORROSION STUDIES OF REACTOR MATERIALS BY HIGH TEMPERATURE AND HIGH PRESSURE WATER LOOP. I. CORROSION OF Zr AND ITS ALLOYS. Sueo Nomura and Noboru Ito (Japan Atomic Energy Re-

search Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 6: 28-36(Jan. 1964). (In Japanese)

Corrosion and hydrogen pick-up of pure Zr and Zircaloy-2 and -4 were studied by high-temperature and high-pressure water loops in which sample coupons were immersed in flowing demineralized water at 260° and 280°C with velocities of 12.0 and 2.5 m/sec. In most of the experimental runs, two corroding coupons were removed at each 100-hr interval and replaced with new ones. Total immersion time was limited to 400 hr maximum, and a continuous run was carried out for comparison with intermittent runs. Weight gain vs. time curves for Zircaloy-2 at 260°C are different from those at 280°C in shape. Weights of samples gradually increase with time in the former although they are almost saturated at 100 hr in the latter. Neither the effects of water velocity nor dissolved oxygen on corrosion are remarkable, and sample replacement shows little effect on corrosion rate. Hydrogen pick-up vs. time curves correspond well to weight gain vs. time curves at the same water conditions. Pure Zr was found to be corroded more severely than Zircaloy-2. Zircaloy-4 is similar in oxidation behavior to Zircaloy-2 but Zircaloy-4 shows a smaller amount of hydrogen pick-up than Zircaloy-2. (Nucl. Sci. Abstracts of Japan, 3: No. 2, (Apr. 1964))

**22451** CORROSION RESISTANCE OF METALS AND ALLOYS. SECOND EDITION. F. L. LaQue and H. R. Copson, eds. American Chemical Society Monograph Series. ACS Monograph No. 158. New York, Reinhold Publishing Corp., 1963. 721p. $21.00.

The mechanism and theory of corrosion, corrosion testing, and corrosion control are discussed. Corrosion behavior of magnesium and its alloys, aluminum and its alloys, zinc and zinc coatings, tin and tin plate, lead and its alloys, iron and steel, cast irons, stainless steel, chromium plate, nickel–iron alloys, nickel and its alloys, copper and its alloys, platinum metals, beryllium, cobalt, niobium, indium, molybdenum, tantalum, thorium, titanium, tungsten, uranium, vanadium, and zirconium are discussed. Numerous references. (R.E.U.)

## Fabrication

**22452** (AD-436023) JOINING OF BERYLLIUM AND ITS ALLOYS BY WELDING AND/OR BRAZING: AN ANNOTATED BIBLIOGRAPHY. Jack B. Goldmann, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Aug. 1963. Contract NOrd-17017. 36p. (SB-63-61).

Ninety references are given to U. S. and foreign journals, reports, and patents published from 1960 through August 1963. A separate author index is included. (P.C.H.)

**22453** (ANL-6649) FABRICATION OF $UO_2$–STAINLESS STEEL DISPERSION FUEL FOR BORAX-V NUCLEAR SUPERHEAT. Final Report. W. C. Kramer and C. H. Bean (Argonne National Lab., Ill.). Dec. 1963. Contract W-31-109-eng-38. 75p.

The superheat section of the Fifth Boiling Reactor Experiment (BORAX-V) is fueled with enriched uranium (93 wt % $^{235}U$) in the form of $UO_2$ in a matrix of stainless steel. The nondestructive and destructive evaluation of the stainless steel-clad fuel plates, the development and evaluation of procedures for assembly of fuel plates, the evaluation of fuel subassemblies, and the assembly of fuel element components are described. A total of 700 fuel plates were used in fabricating the 175 brazed subassemblies needed to complete 35 BORAX-V superheat fuel elements. (auth)

**22454** (BMI-1218) SEGREGATION IN ARC-MELTED URANIUM–NIOBIUM ALLOYS. Ronald F. Dickerson, Ellis L. Foster, and Walston Chubb (Battelle Memorial Inst., Columbus, Ohio). Aug. 28, 1957. Contract W-7405-eng-92. 52p.

Consumable-electrode arc-melted ingots of uranium-10 wt % niobium alloy have demonstrated a type of macrosegregation known as "banding." Variations of the melting procedure have been unsuccessful in eliminating this segregation. This study was made in an attempt to understand the causes of banding and to point the way toward methods of eliminating it. It was found that banding is a combined effect of gravity segregation in the alloy and heat fluctuations introduced by the arc. The gravity segregations is the result of the mode of solidification of the alloy, and the process has been called "dendrite flotation." Methods of eliminating banding have been tested in a preliminary fashion and found to be effective. (auth)

**22455** (GA-4695) GRAPHITE-MATRIX FUELS DEVELOPMENT FOR THE AVR. Final Report. J. Chin, W. V. Goeddel, J. R. Hooker, C. S. Luby, and D. Stevens (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 1963. Contract AT(40-1)-3119. 74p.

Previously developed techniques for the preparation of radiation-stable coated particles and their fabrication into graphite-matrix spheres for pebble-bed reactors were applied to fuel preparation for the AVR. Triplex pyrolytic-carbon coatings consisting of an inner spongy layer, a middle laminar layer, and an outer columnar layer were applied to $UC_2$ and $(Th,U)C_2$ fuel particles. Several lots of these particles were supplied to ORNL for evaluation, including extensive irradiation testing. In addition, several types of graphite-matrix spheres containing Triplex particles were also fabricated and furnished to ORNL for testing. These fueled spheres (6 cm and 1 to ½ in. in diameter) were initially prepared by hot-pressing techniques; in some, the coated particles were uniformly dispersed throughout the spheres, while others had an unfueled surface layer, the particles being dispersed in the central region (yolk) of the continuous matrix graphite. Techniques were also developed for fabricating fueled spheres using shells of machined graphite. (auth)

**22456** (GEAP-4555) DESIGN AND FABRICATION OF FUEL RODS CLAD WITH STAINLESS-STEEL-LINED ZIRCALOY-2. C. J. Baroch (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Feb. 7, 1964. Contract AT(04-3)-189. 36p.

It was considered possible that fluoride and hydride failures of Zircaloy-2-clad fuel rods might be avoided by lining the inside surface of the Zircaloy-2 cladding with a thin layer of stainless steel. As a consequence, an irradiation test was designed to evaluate the in-reactor performance of this type of cladding. Twenty 101.6-cm (40-in.) pieces of Zircaloy-2 tubing, lined with a very thin layer (about 0.003 cm) of stainless steel, were coextruded on a "best effort" basis. Seventeen of the 20 pieces of tubing were considered satisfactory for the production of fuel rods. Of these 17 tubes, only 11 were reasonably free of blisters on the inside surface, internal and/or external roughness, or gross dimensional variations. The 17 fuel rods, containing $UO_2$ pellets of 95 × 1% theoretical density, were fabricated at the Atomic Power Equipment Department (APED), using standard commercial fuel fabrication practice. The irradiation of twelve of these fuel rods in Special Assembly 7L was begun in August 1961. The irradiation in Assembly 4L of another fuel rod intentionally defected in the plenum was begun in July 1962. The irradiations were scheduled to continue until an average burnup of at least $2.88 \times 10^{20}$ fissions/cm$^3$ (10,000 MWD/T) was achieved by some of the fuel rods. However, the operation

of the VBWR was terminated after an average burnup of $1.94 \times 10^{20}$ fissions/cm$^3$ was achieved. (auth)

**22457** (HW-76573) SUMMARY REPORT, LONGITUDINAL WELD QUALITY, NPR PRIMARY LOOP PIPING. APPENDIX VIII. STATISTICAL ANALYSIS OF FLAW FREQUENCY AND SIZE DISTRIBUTION IN NPR PRIMARY LOOP PIPE LONGITUDINAL WELDS. A. D. Wiggins (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 13, 1963. Contract AT(45-1)-1350. 18p.

A mathematical model was developed for the estimation of the frequency of defects occurring in extrusion processes, acetylene or arc welding processes, and hot or cold rolling of steel. For purposes of concreteness, the mathematical model was developed in terms of application to welding, keeping in mind that extrusion or rolling of steel could equally have been used. (P.C.H.)

**22458** (HW-81075) FABRICATION TECHNIQUES: CAST FIBERFRAX INSULATION FOR THE MODEL HIGH TEMPERATURE GAS LOOP. D. R. Doman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 2, 1964. Contract AT(45-1)-1350. 23p.

Criteria were established for selecting insulating material for the model gas loop with castable Fiberfrax chosen as most nearly meeting the requirements. Techniques were developed for fabricating Fiberfrax insulation into the shapes of reducers, bends, and straight pieces. These techniques were used for fabrication of all such insulation required for the model gas loop. Basically the insulation is made by tamping castable Fiberfrax into a mold of the desired shape with wire or mesh reinforcement added during tamping. Evaporation of the inherent moisture by heating produces the required cast piece. (auth)

**22459** (NP-13816) THE STRUCTURAL STABILITY OF WELDS IN COLUMBIUM ALLOYS. Quarterly Progress Report No. 3, November 1, 1963–February 1, 1964. R. E. Yount (General Electric Co. Advanced Engine and Technology Dept., Cincinnati). Feb. 10, 1964. 73p.

Aging studies of three weld conditions in niobium alloys were completed and aging kinetics compared. D-43 (10% W, 1% Zr, and 0.1% Nb) and B-66 (5% Mo, 5% V, and 1% Zr) alloys were used. Interdendritic spacings of the weld metal were more strongly influenced by power input and cooling rate during welding than by chemical composition. As-welded bend transition was dependent on welding speed. The faster the speed the lower the bend transition temperature for the condition studied. The kinetics of aging in the temperature range of 1600 to 2200°F were strongly influenced by interdendritic spacing, hence by weld parameters. The larger the interdendritic spacing the more sluggish the aging reaction. A double aging reaction was found in the B-66 alloy, one which occurs in the weld zone and a second which involves the heat affected zone. (auth)

**22460** (RFP-366) PLATING BERYLLIUM–COPPER ALLOY WITH A COPPER–SILVER–GOLD LAMINATE. W. H. Roberts (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Jan. 11, 1964. Contract AT(29-1)-1106. 9p.

A procedure was developed for plating a beryllium–copper alloy with a flash of copper, then a flash of silver, and finally a bright gold electrodeposit. Eight basic steps and thorough water rinsing where specified, promoted a Cu–Ag–Au laminate that is sound and attractive. Precleaning was found to be the most important phase, particularly acid pickling, which deoxidizes, brightens, and hereby activates the alloy for subsequent electrodeposition. (auth)

**22461** (UCRL-11214) FIRST-STAGE DENSIFICATION OF $CaF_2$ UNDER PRESSURE AND TEMPERATURE. (thesis). Yasou Hashimoto (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 21, 1964. Contract W-7405-eng-48. 37p.

The initial densification of spherical $CaF_2$ powders was determined by dilatometric and microscopic observations. The experiments consisted of heating the powder to a fixed temperature at a constant rate under a load and then releasing the load and quenching. Further experiments were performed by heating to a fixed temperature without load application, rapidly applying the load and holding for 40 sec. or 1 hr, and releasing the load and quenching. The initial stages of hot pressing were divided into three regions. Region I exhibited little densification. Region II showed densification by limited plastic flow and fracturing. Region III above a pressure dependent critical temperature, exhibited extensive densification due to plastic flow, fracturing of particles, and their subsequent rearrangement. (auth)

**22462** (JPRS-22336) STUDIES IN CASTING, PRODUCTION, AND REFINING OF HIGH-TEMPERATURE ALLOYS. Translated from Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 9: 190-203; 218-26(1962). 34p. (OTS-64-21047)

Four papers translated from the Russian-language journal Issledovaniya po Zharoprochnym Splavam (Research on High-Temperature Alloys), Vol. 9, 1962 are presented. Separate abstracts were prepared for 3 papers. One paper was previously abstracted as NSA 17: 22176. (M.C.G.)

*For abstracts of individual papers see: 22463, 22464, and 22499.*

**22463** (JPRS-22336(p.6-9)) PRODUCTION AND PROPERTIES OF SINGLE CRYSTALS OF THE REFRACTORY METALS TUNGSTEN, RHENIUM, TANTALUM, MOLYBDENUM, AND NIOBIUM. E. M. Savitskii, Ch. V. Kopetskii, A. I. Pekarev, and M. I. Novosadov. Translated from Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 9: 192-4(1962).

Equipment for zone electron-beam melting of metals for purification and preparation of single crystals is described and diagramed. Nb, Mo, Ta, Re, and W rods were etched after zone melting and the boundaries of single crystals revealed. The Vickers hardness values were 170, 79, 75, 154, and 345 kg/cm$^2$ for Mo, Nb, Ta, Re, and W, respectively. Single crystals of Mo, Nb, and Ta, subjected to tensile tests, showed a transverse constriction of about 100%. (M.C.G.)

**22464** (JPRS-22336(p.23-34)) ZONE REFINING OF NIOBIUM BY THE ELECTRIC-ARC METHOD. A. I. Evstyukhin, V. V. Nikishanov, and I. V. Milov. Translated from Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 9: 218-226(1962).

Zone refining of niobium by the electric-arc method is described. Advantages and potentialities of this method are discussed. Under the system of melting studied (rate motion of the zone 0.5 mm/sec, width of zone 20 mm), the limit of refinement was not achieved in 120 to 130 passages. Tracer techniques were found to be effective in determining degree of purification. (M.C.G.)

**22465** WELDING NIOBIUM PRODUCED BY VACUUM ARC AND ELECTRON BEAM MELTING. E. I. Istomin and Yu. P. Gumenyuk (Inst. of Electric Welding, Academy of Sciences, Ukrainian SSR). Avtomat. Svarka, No. 1, 25-7 (Jan. 1964).

The results of research on weldability of niobium obtained by various methods of melting and the selection of feasible methods for welding it are presented. Niobium of various purity was studied. Results showed that niobium produced by electron-beam melting can be readily joined by both electron-beam and argon-arc methods of welding. Sheet niobium produced by vacuum-arc melting with a relatively high oxygen and nitrogen content is better joined by the electron-beam method, since the plastic properties of the metal decrease sharply during argon-arc welding as a result of an additional increase in admixture content. (OTS)

**22466** BRAZING AND WELDING OF BERYLLIUM. H. Weik (Univ. of Cincinnati). Metall, 18: 235-43(Mar. 1964). (In German)

The state of technology for brazing and welding of beryllium is reviewed. For rods the best methods of joining were considered to be brazing in a vacuum with silver and Ag-0.5% Li braze and resistance welding with current strength of 80,000 a/cm$^2$. For sheets the best methods were considered to be point brazing with Ag-Cu solder, point welding in the double-press method, and electric arc welding. An ultra-sound welding method is also described. (M.C.G.)

**22467** FURNACE FOR VACUUM MELTING AND PRESSURE CASTING OF RADIOACTIVE OR TOXIC METALS. P. Bourse, J. Feneyrol, B. Hocheid, and J. Sernissi (Commissariat a l'Energie Atomique, Paris). Rev. Met. (Paris), 61: 189-97(Feb. 1964). (In French)

A new furnace is described, which is designed so as to reduce operational difficulties and the risk of accidents occurring, such as in the case of plutonium. (P.C.H.)

**22468** DUPLEX CARBON-COATED FUEL PARTICLES. R. A. Reuter (Union Carbide Corp., Lawrenceburg, Tenn.). 23p. (CONF-187-124)

From American Nuclear Society Meeting, New York, Nov. 1963.

Duplex coated fuel particles consist of two discontinuous layers of pyrolytic coating. Theoretical advantages of the layered construction appear substantiated in irradiation tests. The inner coating is applied at temperatures of 1400 to 1750°C and the high density, more graphitic final coating is applied at 1800 to 2200°C. Coating microstructure may be varied from a rough surfaced, highly oolitic conical pyrolytic to a smooth, glossy, fine coned pyrolytic. The force necessary to crush these particles is inversely proportional to pyrolytic cone length. Irradiation of Duplex particles at temperatures up to 1200°C and burn-ups to 30 at.%, show a steady $^{85}$Kr R/B of $10^{-5}$. (auth)

**22469** METHOD FOR THE PREPARATION OF A MAGNESIUM-ZINC-ZIRCONIUM ALLOY FOR CASTING PURPOSES. Keith Roberson and Elmer Harold Mossner (to Dow Chemical Co.). German Patent 1,160,190. Dec. 27, 1963. Priority date Dec. 20, 1956, United States.

The alloy, the method of preparation of which is described, is composed of 4.8 to 6.5% zinc, 0.1 to 0.9% zirconium, and magnesium. A notable feature of the alloy is that during solidification, the zinc-zirconium composition ($Zn_5Zr_2$) is not substantially reduced by liquation. The method comprises the steps of alloying zinc and zirconium with liquid magnesium between 654 and 787°C, of settling and soaking the liquid alloy obtained at a temperature between 648 and 690°C, and of separating the overlying metal from the rest. (Gmelin Inst.)

**22470** METHOD FOR THE PRODUCTION OF URANIUM-CARBON ALLOYS OF HIGH DENSITY. Jack Williams and Charles Brian Davis (to United Kingdom Atomic Energy Authority). German Patent 1,160,633. Jan. 2, 1964. Priority date Sept. 8, 1959, [United Kingdom].

The method described is especially suited for the production of uranium-carbon alloys, the composition of which is equal to that of the monocarbide of uranium and which can contain also plutonium. The method comprises the steps of cold pressing the powder mixture and of bringing the pressed objects into a furnace that is at a temperature of 1000 to 1125°C. It is advantageous to sinter under vacuum. (Gmelin Inst.)

**22471** APPLICATION OF A PLUTONIUM ALLOY FOR THE PRODUCTION OF CAST PIECES FREE FROM HAIR CRACKS. H. Roy Gardner (to U. S. Atomic Energy Commission). German Patent 1,160,644. Jan. 2, 1964. Priority date Mar. 31, 1960, United States.

The alloy used is composed of 0.05 to 0.15% iron and the remainder of plutonium. (Gmelin Inst.)

## Properties and Structure

**22472** (AD-423413) MECHANICAL AND PHYSICAL PROPERTIES OF TZM MOLYBDENUM ALLOY SHEET AND OF TUNGSTEN SHEET. Quarterly Progress Report No. 4, August 1-October 31, 1963. J. A. Hamilton and Clifford L. Dotson (Southern Research Inst., Birmingham, Ala.). Nov. 15, 1963. Contract N600(19)59530. 40p. (N64-11758)

The determination of the recrystallization temperatures of tungsten sheets was completed; the recrystallization temperature of the 0.060- and 0.100-in. tungsten sheet was 2400°F. Compression and bend-property evaluations on the tungsten sheet material were conducted. The original plan to evaluate both the TZM and tungsten sheet in the coated condition was revised to eliminate the evaluation of the coated tungsten sheet. (auth)

**22473** (AGN-8090) THE DETERMINATION OF THE LATENT HEAT OF VAPORIZATION, VAPOR PRESSURE, ENTHALPY, SPECIFIC HEAT, AND DENSITY OF LIQUID RUBIDIUM AND CESIUM UP TO 1800°F. P. Y. Achener (Aerojet-General Nucleonics, San Ramon, Calif.). Jan. 1964. Contract AT(04-3)-368. 86p.

The latent heats of vaporization, vapor pressures, enthalpies, and densities of rubidium and cesium were experimentally determined. Equations derived for the latent heats of vaporization (Btu/lb) were: for rubidium, from 970 to 1805°F, $h_{fg} = 414.8 - 0.0513T$ and for cesium, from 1002 to 1596°F, $h_{fg} = 257.4 - 0.0362T$. The vapor pressure equations derived were: for rubidium, $\log_{10}P = 5.20071 - [6994.68/(T + 459.7)]$, (P in psia, T in °T) and, for cesium, $\log_{10}P = 5.09475 - [6680.185/(T + 459.7)]$. Normal boiling points of 1274.4°F and 1241.1°F for rubidium and cesium, respectively, were obtained from these equations. The enthalpies (Btu/lb where $H^0$ = absolute enthalpy) of rubidium and cesium were measured in a Bunsen ice calorimeter in the temperature range of 150 to 1650°F. The data obtained fit the following equations: for rubidium, $H^0_T - H^0_{32°F} = 9.012 + 0.09915T - 1.553 \times 10^{-5} T^2 + 4.329 \times 10^{-9} T^3$ and for cesium, $H^0_T - H^0_{32°F} = 2.711 + 0.08543T - 4.803 \times 10^{-5} T^2 + 1.995 \times 10^{-8} T^3$. These equations were used to determine the specific heats (Btu/lb-°F) as follows: for rubidium, $C_p = 0.09915 - 3.106 \times 10^{-5} T + 1.299 \times 10^{-8} T^2$ and for cesium, $C_p = 0.08543 - 9.605 \times 10^{-5} T + 5.985 \times 10^{-8} T^2$. The densities (g/cm$^3$) of liquid rubidium and cesium were measured by the pycnometer method. The following equations were obtained: for rubidium, $d = 1.472/1 +$

$1.3309 \times 10^{-4} (T - 102) + 5.2106 \times 10^{-8} (T - 102)^2$ and for cesium, $d = 1.84/1 + 1.1755 \times 10^{-4} (T - 82.4) + 7.656 \times 10^{-8} (T - 82.4)^2$ (auth)

**22474** (ATL-A-142) INVESTIGATION OF THERMAL-STRESS-FATIGUE BEHAVIOR OF STAINLESS STEELS. Quarterly Progress Report No. 9, January–March 1964. K. E. Horton and J. M. Hallander (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 27p. (EURAEC-1030)

Strain-cycle-fatigue and thermal-stress-fatigue test results for A302B ferritic steel and 403 martensitic stainless steel are in agreement. Type 403 specimens TSF-tested at higher mean temperatures fail sooner than those tested at lower mean temperatures. There is no break in the slope of the failure curves for 403 steel; however, there may be for A302B steel. TSF-induced tempering causes a continuous increase in plastic strain range during cycling of 403 stainless steel specimens. This increase is due to a lowering of the yield point by tempering. The program on A387D steel (Croloy $2^1/_4$) has started. (auth)

**22475** (BATT-4673-T7) THE SPECIFIC HEAT, THERMAL CONDUCTIVITY, AND VISCOSITY OF LIQUID CESIUM. Topical Report. A. W. Lemmon, Jr., H. W. Deem, E. A. Eldridge, E. H. Hall, J. Matolich, Jr., and J. F. Walling (Battelle Memorial Inst., Columbus, Ohio). Feb. 29, 1964. Contract NAS-5-584. 41p. (NASA-CR-54018)

The specific heat, thermal conductivity, and viscosity of liquid cesium were determined at temperatures to 2100°F. Specific heats were determined by measurements in a Bunsen ice calorimeter of the heat content of a cesium sample encapsulated in Nb-1 Zr alloy. Thermal conductivities and electric resistivities of cesium were measured in a steady-state, longitudinal-heat-flow apparatus. Corrections for the conduction of the container required that the thermal conductivities and electrical resistivities of the Nb-1 Zr alloy also be measured. By finding the decrement of an oscillating cylinder partially filled with cesium, the desired viscosity values were computed from the theoretical relation. (auth)

**22476** (BATT-4673-Q13) ENGINEERING PROPERTIES OF POTASSIUM AND CESIUM. [illegible] Quarterly Report, October 1 through December 31, [illegible] Alexis W. Lemmon, Jr. (Battelle Memorial Inst., Columbus, Ohio). Jan. 30, 1964. Contract NAS5-584. 19p.

An evaluation is made of the initial results and techniques of the bare-wire-probe apparatus to obtain values for the thermal conductivity of potassium vapor. Measurements of the thermal conductivity of nitrogen made at room temperature to assess the reliability of the bare-wire-probe apparatus have given a value of 2.6 watt $cm^{-2}$ $cm°C^{-1}$. The results of initial measurements on potassium vapor between 400 and 800°C, however, revealed that it did not respond as nitrogen did to this method of measurement. Cesium in various sized ampoules for loading each of the test cells was received. Impurity levels were judged exceptionally low on the basis of freezing-point curves and spectrographic analyses. (N.W.R.)

**22477** (BMI-X-10081) FISSION-PRODUCT RELEASE FROM FUEL-ELEMENT CLADDINGS. Quarterly Progress Report, January–March 1964. Thomas S. Elleman, George C. Cocks, Josef Bugl, and Arthur A. Bauer (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 14p. (EURAEC-1031)

The diffusion of solid fission products in Fe-29 wt % Ni-13 wt % Cr alloy, which has a face-centered-cubic structure, was investigated. Results showed that cerium, barium, iodine, and ruthenium exhibited the same distribution and diffuse more slowly than the tellurium and zirconium/niobium fission products. The diffusion coefficients of the solid fission products in Fe-20 wt % Cr are compared with those for the above mentioned alloy. In the iron-chromium alloy, the activation energies for the diffusion of tellurium and ruthenium are about the same as the activation energy for the self-diffusion of chromium which is significantly higher than the activation energies for barium, cerium, and iodine. The diffusion of cerium, barium, and iodine in both alloys appears to give the same diffusion activation energy. The diffusion of xenon-133 from chromium-iron alloy at 800, 1025, and 1190°C suggests that the fission gas precipitated at the surface. (N.W.R.)

**22478** (CONF-45-3) PHASE RELATIONSHIPS IN THE URANIUM–NITROGEN SYSTEM. J. Bugl and A. A. Bauer (Battelle Memorial Inst., Columbus, Ohio). [1963]. Contract W-7405-eng-92. 21p.

From American Ceramic Society Basic Science Division Meeting, Washington, D. C., Oct. 1963.

Studies were made to develop uranium mononitride as a fuel material and to provide information on the identity and equilibrium relationships between the various phases. Crystallography of uranium–nitrogen compounds is discussed. Preparation and characterization of UN are described. Melting point and decomposition pressure, solubility in liquid uranium, decomposition pressure of $U_2N_3$, and equilibrium compositions in the $U_2N_3$–$UN_2$ region were determined. (M.C.G.)

**22479** (CONF-281-48) SELF-DIFFUSION OF BERYLLIUM IN UNIRRADIATED COLD-PRESSED AND SINTERED BERYLLIUM OXIDE. H. J. de Bruin and G. M. Watson (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 29p.

From International Conference on Beryllium Oxides, Sydney, Oct. 1963.

Diffusion of beryllium-7 through polycrystalline unirradiated specimens of BeO was studied as a preliminary step to a study of diffusion in irradiated material. Beryllium-7 was deposited on one end of cylindrical specimens by exchange and adsorption from aqueous solution. The depth of penetration perpendicular to the surfaces of deposition was determined after annealing the specimens at definite, pre-determined conditions. A simple lapping device of high precision was developed to determine penetration depths. For the polycrystalline cold-pressed and sintered BeO studied, the diffusion behavior between 1150 and 1800°C is described by the empirical relation: $D = 2.49 \pm 10^{-3} \exp[-(62.5 \times 10^3)/RT] cm^2/sec$. A diffusion model is proposed based on vacancy migration which suggests identical activation energies for diffusion in both a and c directions in single crystals and predicts an activation energy of the correct order of magnitude. Furthermore the model predicts that the frequency factor in the direction perpendicular to the c axis should be about 50 percent higher than that parallel to the c axis. (auth)

**22480** (DCL-59-12-210) GRAIN GROWTH STUDIES OF BERYLLIUM OXIDE. P. P. Turner (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Dec. 24, 1959. Contract AT(11-1)-171. 27p.

Discussion is given regarding the importance of microstructure and grain growth on physical properties. The technical program leading up to the partial inhibition of

grain growth in beryllium oxide is described and illustrated with numerous photomicrographs. Recommendations for future work on grain growth inhibition in beryllium oxide are included. (auth)

**22481** (EURAEC-964) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Quarterly Report No. 4. W. Siegfried and S. Zimering (Battelle Memorial Inst. International Div., Geneva). Mar. 1964. Work Performed under United States Euratom Joint Research and Development Program. Contract 100-62-12 RDS. 141p.

Evaluation of the results of time-to-rupture tests was continued. For this, the following simplifications have been used: the heat of activation was taken as a function of the temperature, and the entropy of activation as a function of the stress. However, deviations from the calculated values occurred while evaluating results of very long times-to-rupture of different steels. These deviations are due to the fact that the processes taking place during creep cannot be described by a simple Arrhenius equation; as the heat of activation and the entropy of activation are given by another Arrhenius equation, with a different value for the heat of activation, a more complicated form of equation has to be used. A mathematical investigation showed that these kinds of processes can be described by fractional iterates of logarithmico-exponential functions: $\dot{\epsilon} \cong e_{r_T}(c_r\sigma)$, where $\sigma$ = stress, $\dot{\epsilon}$ = speed of creep, and $c_r$, $r_T$ = parameters of the temperature. Some methods were developed for the practical determination of the parameters $c_r$ and $r_T$ on the basis of short-time tests. It was concluded that the introduction of the logarithmico-exponential type functions will present the following advantages: significant improvement of the extrapolation after very long times-to-rupture and a more detailed and deeper explanation of the physical processes taking place during creep of industrial steels, by using these new mathematical functions. Investigations of the relation between phenomenological thermodynamic values of the formation of rupture and the apparent thermodynamic values of the creep process were enlarged in order to permit finding out the correlation with investigations performed by other laboratories for the determination of the notch-brittleness of heat resistant steels. Evaluation of the test results indicated by the Berkeley Nuclear Laboratory, Berkeley/Glos. was continued. The results are discussed on the basis of the theories of the creep process developed by John E. Dorn and his collaborators. A program for the execution of in-pile tests, in order to verify the theoretical conclusions, was established. A summary in tabular form gives a general view of the present state of the work. (auth)

**22482** (EURAEC-999) ELECTRON MICROSCOPICAL OBSERVATIONS OF PRECIPITATION, COLD-WORK AND ANNEALING PHENOMENA IN ZIRCONIUM. P. Gondi, A. M. Marazzi, G. F. Missiroli, and A. Tamba (Bologna. Università. Istituto di Fisica "A. Righi."). [nd]. Work performed under United States–Euratom Joint Research and Development Program. 13p.

Results of electron microscope studies on precipitation and dissolution phenomena occurring directly inside the microscope during observations on Zr; hydride structures that come about in Zr with hydrogen at 3 at. %, as a consequence of various thermal treatments, such as slow cooling, quenching, and annealing; and distribution of the dislocations corresponding to various cold-work and recovery stages, are discussed. Starting from cold-worked specimens, the effects of annealing were also studied. Several photographs are included. (P.C.H.)

**22483** (HR-64-258) THERMAL-MECHANICAL HISTORY AND THE STRENGTH OF MAGNESIUM OXIDE SINGLE CRYSTALS. I. MECHANICAL TESTS. R. J. Stokes (Honeywell Research Center, Hopkins, Minn.). Mar. 1964. Contract AF33(616)-7465. 44p.

Dislocation impurity interactions in magnesium oxide and their effect on mechanical properties between room temperature and 1000°C were investigated. The results showed that impurity precipitate particles present in single crystals can be redistributed by heat treatment. Their size and density affects the lattice resistance to fresh dislocations and thus the yield strength at room temperature. Above 1200°C impurities go into solid solution and strength drops to 0.7 of the as-received fully precipitated value. Fresh dislocations can be locked by heating above 600°C to produce yield phenomena at room temperature. The upper yield strength increases with time and temperature particularly when aging temperature exceeds 1000°C. Locking is attributed to diffusion of impurities and point defects to dislocations. The basic temperature dependence of the yield strength contains two regions: up to 500°C strength decreases rapidly suggesting a dislocation cutting mechanism during flow. Material preheated above 1200°C shows a stronger dependence than as-received material due to finer dispersion of impurities in solid solution. Above 500°C strength decreases linearly at a rate equal to elastic modulus suggesting long range interaction of dislocations with internal stress fields. Superimposed on this basic temperature dependence there is, for material preannealed above 1200°C, a hump due to reprecipitation between 500 and 1000°C. (auth)

**22484** (HW-SA-3131) PLUTONIUM-BEARING REFRACTORY CARBIDES. J. B. Burnham, R. E. Skavdahl, and T. D. Chikalla (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [1962]. Contract AT(45-1)-1350. 30p. (CONF-206-6)

Investigations of the PuC system revealed a number of promising properties of these compounds. High burnup irradiation under severe heat flux conditions showed a moderate fission gas release. The high-temperature vapor pressure of PuC prompted a study of the pseudo-binary PuC–ZrC and PuC–TaC systems. A number of the mixed carbides melted at temperatures above 2500°C. Cermets were prepared by high energy impaction with PuC as fuel particles in a matrix of Ta, W, and Mo, respectively. Good distribution and densities were achieved with all of these combinations. Examination of the compacts showed negligible fuel-matrix interaction at 1200°C. (auth)

**22485** (MCW-1483) INVESTIGATIONS OF SOME EXPERIMENTAL FUEL ELEMENT ALLOYS WITH THE ELECTRON MICROPROBE. L. A. Fergason, D. L. Parker, and N. F. Neumann (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Apr. 15, 1964. Contract W-14-108-eng-8. 19p.

The microstructures of seven alloys were investigated with the Cambridge microprobe. Six of the alloys were uranium containing the following combinations of other elements: S; P; Zr, Fe, and Al; Zr and P; Fe and Si; and Al, Fe, and Si. One was a section of a thorium fuel element containing 2.5 wt % U and 1 wt % Zr. (auth)

**22486** (NAA-SR-7465) PREPARATION OF URANIUM MONOCARBIDE SINGLE CRYSTALS. H. Nadler (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 30, 1964. Contract AT(11-1)-Gen-8. 63p.

Single crystals of uranium monocarbide (UC), ¼ in. in diameter by 2-in. long, were prepared from arc-melted rods of stoichiometric and off-stoichiometric compositions by a two-step process. First, an arc-melted rod was float zone melted in an electron beam furnace to form a superstoichiometric two-phase structure, wherein uranium dicarbide ($UC_2$) platelets precipitated along the [100] crystallographic planes of the UC matrix. Subsequent decarburization of the $UC_2$ platelets by hydrogen reduction produced at UC single crystal. Precise control of the decarburization process was required to achieve stoichiometry. (auth)

**22487** (NAA-SR-8262) STUDY OF METALLURGICAL DEFECTS IN APM PRODUCTS. P. B. Ferry and W. H. Friske (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 15, 1964. Contract AT-11-1-GEN-8. 31p.

A discussion is presented of metallurgical defects found in Aluminum Powder Metallurgy (APM) extrusion billets and fabricated shapes. The defects observed included macrosegregation, microsegregation, inclusions, and voids. Macrosegregation has been observed as darkly etched bands in billet stock, extruded rods, and finned tubing. Microsegregation, visible by optical microscopy at high magnifications, was observed as stratified layers of the dispersed phase. Inclusions found in extrusion billets are believed to be iron-rich particles, originating in the powder process. The larger inclusions were broken up into stringers, during subsequent fabrication. Voids were present in billet sections, and have been observed in extruded tubing. The use of nondestructive test techniques for detecting these defects was investigated. Ultrasonic tests were successful in detecting macrosegregation in billets and voids in sheet stock. Eddy current tests located small inclusions and voids in tubing. An electron microprobe x-ray analyzer was employed to investigate the composition of inclusions and segregated zones. (auth)

**22488** (NAA-SR-8381) PHASE EQUILIBRIA-FREE ENERGY RELATIONSHIPS IN LIQUID SODIUM SYSTEMS. D. L. Johnson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 15, 1964. Contract AT(11-1)-Gen-8. 39p.

Diffusion and transfer of solutes through a liquid sodium medium are dependent upon the free energy gradient. Because most of the reactants and products of interest are soluble in sodium, standard reaction free energy data alone are not adequate for predicting diffusion and transfer reactions in liquid sodium. Consequently, considerations of free energy changes for reactions in liquid sodium systems must include the free energy of solution. Partial-molal enthalpy and entropy of solution of several solutes were calculated, by setting up computer programs for 15 mathematical models from solubility data. From these properties, partial molal free energy and the degree of nonideality were estimated. Iron, magnesium, nickel, and silver exhibited negative nonideality with respect to entropy, and slightly positive or negative nonideality with respect to enthalpy. Calcium, $Na_4Sn$, and sodium (gold solute) exhibited ideality with respect to entropy and, except for sodium (gold solute), positive nonideality with respect to enthalpy. Intermetallic compounds between sodium and selenium, cadmium, bismuth, tellurium, antimony, and lead exhibited large negative nonideality with respect to both entropy and enthalpy. Carbon exhibited large negative nonideality with respect to entropy. The degree of nonideality of sodium hydride and sodium oxide was not determined, but both exhibited positive enthalpy and entropy with respect to pure solid. A comparison of solution free-energy data permitted the evaluation of solution behavior and comparative stability in purification and transfer processes. (auth)

**22489** (NLCO-903) THE INVERSION OF POLE FIGURES FOR MATERIALS HAVING ORTHORHOMBIC SYMMETRY. Peter R. Morris (National Lead Co. of Ohio, Cincinnati). Apr. 10, 1964. Contract AT(30-1)-1156. 62p.

A method for inverting pole figures for materials having orthorhombic symmetry is described. The method entails expansion of the axis distribution in a series of spherical surface harmonics of appropriate symmetry, even in $x_1$, $x_2$, $x_3$. Truncation of the series at order n = 2, 4, 6, . . . , 2m, where m is a non-negative integer, gives rise to n/2 systems of 2, 3, n/2 + 1 simultaneous linear equations in a like number of variables, requiring a minimum of n/2 + 1 pole figures for solution. A method for evaluating the goodness of fit of the inversion process is suggested. (auth)

**22490** (ORNL-3591(p.141-6)) FISSION-GAS RELEASE FROM SINGLE-CRYSTAL $UO_2$. R. M. Carroll, J. G. Morgan, O. Sisman, T. W. Fulton, and R. B. Perez (Oak Ridge National Lab., Tenn.).

Studies of fission-gas release from $UO_2$ single crystals during irradiation indicated that burnup and fission rate have a large influence on the gas release rate. Increased fission rate was observed to retard the escape of fission gas, and the release rate decreased with burnup. The latter effect was possibly caused by irradiation smoothing of the specimen surface. A model was proposed to explain the high-temperature gas release, based on the concept that a trapping mechanism (rather than diffusion) is the rate-controlling process for escape of fission gas from $UO_2$. (auth)

**22491** (ORNL-3591(p.160-4)) EQUILIBRIUM STUDIES IN THE SYSTEM $ThO_2-UO_2-UO_3$. L. O. Gilpatrick, H. H. Stone, and C. H. Secoy (Oak Ridge National Lab., Tenn.).

The equilibrium between orthorhombic $U_3O_{8-y}$ and the cubic solid-solution $ThO_2-UO_{2+x}$ was determined at the oxygen pressure of 1 atm of air over the range from 700 to 1600°C. In addition, portions of the isobaric surface, $P_{O2}$ = 0.2 atm, within the one-phase, cubic solid-solution region were determined. The boundary composition of the cubic phase at 700°C was very close to $X_{ThO_2}$ = 0.4, $X_{UO_3}$ = 0.267, $X_{UO_2}$ = 0.333, and changed very little with temperature to above 1200°C. At higher temperatures the $UO_3$ mole fraction (excess oxygen content) increased smoothly as $X_{ThO_2}$ decreased. A maximum oxygen content close to $X_{UO_3}$ = 0.4 was reached at about 1525°C, the $U_3O_{8-y}$-to-$UO_{2+x}$ transition temperature. The mole fraction of $ThO_2$ reached zero at this temperature. Compositions of the $U_3O_{8-y}$ phase were in good agreement with the literature. (auth)

**22492** (ORNL-TM-818) AN EVALUATION OF NONSINTERED $UO_2$ FUEL FOR AN N.S. SAVANNAH CORE. T. D. Anderson, V. O. Haynes, and W. C. Thurber (Oak Ridge National Lab., Tenn.). May 1964. Contract W-7405-eng-26. 34p.

The use of nonsintered $UO_2$ fuel is one means of reducing the cost of a replacement core for the N.S. Savannah reactor. This evaluation of nonsintered $UO_2$ was made with respect to both fuel-cycle economics and in-pile performance. The estimated reduction in fuel-cycle cost resulting from the use of nonsintered $UO_2$ is between 5 and 9%. Based on the presently available information, it was concluded that nonsintered $UO_2$ fuel could be applied to the N.S. Savannah with confidence in all aspects of in-

reactor performance with one important exception. The susceptibility of this fuel to waterlogging failures and the consequences of such failures are uncertain. Thus, it was concluded that more experience will be necessary before nonsintered $UO_2$ could be used in the N.S. Savannah reactor with confidence. (auth)

**22493** (PB-171809-6) CRYOGENIC MATERIALS DATA HANDBOOK. Progress Report No. 14. F. R. Schwartzberg, S. H. Osgood, R. D. Keys, and T. F. Kiefer (Martin-Marietta Corp. Aerospace Div., Denver). Jan. 1, 1964. Contract AF33(657)-9161. 130p.

A handbook on the properties of solid materials at low temperatures is presented. Materials receiving the most interest are: aluminum alloys, cobalt alloys, copper alloys, beryllium alloys, steels, stainless steels, nickel alloys, titanium alloys, plastic-fiberglas laminates, and vanadium alloys. (N.W.R.)

**22494** (TID-19959(Rev.)) RESISTIVITY AND HALL EFFECT IN LIQUID METALS (thesis). Bernard Springer (Chicago. Univ. Inst. for the Study of Metals). [1963]. Contract [AT(11-1)-636]. 48p.

A liquid metal is assumed in which the unscreened electron-ion interaction is the sum of spherically symmetric potentials. Using an exact expression for the conductivity tensor in a magnetic field, expressions are obtained for the Hall constant and for the zero-magnetic-field frequency-dependent conductivity tensor $\sigma^0_{\mu\mu}(\omega)$ in the form of power series expansions in the potential. Effects due to the electron spin are ignored. Calculations are done for Zn, Li, and Na using the pseudopotentials calculated by Harrison. For Zn it is shown that the series for $\sigma^0_{\mu\mu}(\omega)$ converges slowly if it converges at all. It is concluded that the small pseudopotential approximation is not convenient for, and possibly not valid for, dealing with electrical transport in liquid metals. (auth)

**22495** (UCRL-7022(Rev.1)) THE CRYSTAL STRUCTURE AND POLARITY OF BERYLLIUM OXIDE. Deane K. Smith, Herbert W. Newkirk, and J. S. Kahn (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 1, 1963. Contract W-7405-eng-48. 39p. (CONF-281-47)

From International Conference on Beryllium Oxides, Sydney, Oct. 1963.

New x-ray intensity data from synthetic beryllium oxide crystals verified the distorted wurtzite-type structure previously reported by Jeffrey, Parry, and Mozzi. The oxygen z parameter obtained from the refinement is $0.3786 \pm 0.0005$ compared to 0.375 for the undistorted structure. The resulting structure has a Be-O bond distance of $1.659 \pm 0.003$ Å parallel to the c-axis and three distances of $1.645 \pm 0.003$ Å completing the tetrahedral coordination. The difference of 0.014 Å appears statistically significant and indicates that the long bond has slightly more ionic character than the other three. Measurement of the signs of the piezoelectric and pyroelectric charge and the shape and rate of etch pit formation were correlated with the internal crystal structure to identify the crystallographic polarity. On crystals showing a hemimorphic habit, consisting principally of a hemipyramid, a prism and a dominant pedion, the dominant pedion was shown to be terminated by oxygen atoms. In oxidizing etching media the $\{00.\bar{1}\}$ surfaces are much more reactive than the $\{00.1\}$ surfaces. The differences in surface reactivity are consistent with a modified version of the Warekois-Gatos hybrid orbital bonding model for $A_{III}$-$B_V$ and $A_{II}$-$B_{VI}$ compounds. A discussion is presented relating the crystalline structure of beryllium oxide to its mechanical properties and mechanism of crystal growth. (auth)

**22496** (USBM-U-1109(p.5-8)) HAFNIUM CARBIDE. (Bureau of Mines. Albany Metallurgy Research Center, Ore.).

Ingots containing carbon in excess of that required to form hafnium carbide were evaluated and selected properties determined. The ingots, with about 8.8 to 12.4 wt % carbon, were usually free of cracks but contained some porosity. Bend-rupture strengths of entire ingots at room temperature were determined. Thermal expansion, electrical resistivity, and reactivity with the atmosphere were determined in sections cut from the ingots. (auth)

**22497** (WADD-TR-60-646(Pt.3, Vol.II)) CARBONIZATION OF PLASTICS AND REFRACTORY MATERIAL RESEARCH. VOLUME II. REFRACTORY MATERIALS. G. M. Kibler, T. F. Lyon, M. J. Linevsky, and V. J. DeSantis (General Electric Co. Flight Propulsion Lab. Dept., Evendale, Ohio). Aug. 1962. Contract AF33(616)-6841. 180p.

Results of investigations on the vapor pressures of pressures of selected refractory materials and the spectral emissivities of similar classes of compounds are presented. Vapor pressure studies were conducted through the application of Langmuir evaporation, Knudsen effusion, matrix isolation, and resonance line absorption techniques. The vaporization of hafnium and zirconium nitrides was studied by the Knudsen effusion method; the Langmuir evaporation method was applied to pure hafnium metal. Matrix isolation of vapor over thoria proved successful and structural assignments were made to various bands in the infrared absorption spectra of the matrix isolated species. Resonance line absorption photometry studies of $TiB_2$ were completed. Normal spectral emissivity data from 0.4 to 5.0 microns and from 1500 to 2500°K, supported by systematic methods of material characterization, were obtained for the compounds niobium diboride, zirconium diboride, titanium diboride, tantalum nitride, hafnium nitride, and zirconium nitride. (auth)

**22498** (WANL-PR-M-006) PILOT PRODUCTION AND EVALUATION OF TANTALUM ALLOY SHEET. Fifth Quarterly Report, May 15 to August 15, 1963. R. L. Ammon and R. T. Begley (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Oct. 15, 1963. Contract N600(19)59762. 26p.

The evaluation of T-222 (Ta-9.6 W-2.4 Hf-0.01C) sheet was continued. Duplicate tensile tests of recrystallized and stress-relieved sheet were conducted at 1800 to 3500°F. The excellent high temperature strength of T-222 reported previously was confirmed. Stress rupture properties at 2400 and 3000°F were established. Aging studies to determine optimum thermal and mechanical treatments for improved high temperature tensile strength were initiated. Electron microscopy and phase identification studies are being conducted to correlate mechanical properties with structure. The processing of an additional 3" diameter ingot of T-222 and several smaller ingots of experimental compositions was initiated. (auth)

**22499** (JPRS-22336(p.2-5)) PROPERTIES OF CAST TUNGSTEN. M. I. Gavrilyuk and E. N. German. Translated from Issled. po Zharoproch. Splavam, Akad. Nauk SSSR, Inst. Met., 9: 190-2(1962).

High-temperature properties of cast tungsten, produced by electric-arc melting in a vacuum furnace, were studied. The short-term strength of tungsten was determined as a function of temperature. The strength of the deformed metal varied comparatively little up to temperatures of the order of 1200°C. When a temperature of 1500°C was reached, the strength dropped very sharply and then de-

creased more smoothly as the temperature was further increased. In contrast to this, the strength of annealed tungsten decreased continuously as the temperature was increased. The modulus of elasticity of tungsten decreased slightly with increasing temperature. (M.C.G.)

**22500** (UCRL-Trans-1042(L)) THE FRITTING OF PURE OXIDES WITH ADDITIONS. R. Pampuch. Translated by Sergey Shewchuck (Univ. of California, Lawrence Radiation Lab., Livermore), from Bull. Soc. Franc. Ceram., 46: 3-11(1960). 21p.

The effects of additions, as a consequence of adsorption, on the frittability of pure oxides were investigated. Studies were made on BeO, whose impurity content did not exceed 0.4 to 0.7%. The preheated samples were fritted at temperatures of 1200 to 1600°C, either in the form of cold-compressed cylinders or non-pressed powders. Fritting was traced by determining the density of the samples and by observations under the microscope of their recrystallization. Microstructures of mixtures of BeO with various additions, after fritting at 1200, 1450, and 1600°C for 10 hr, are shown. Additions that were very active were MnO, CaO, $Fe_2O_3$, $TiO_2$, and CoO(ZnO). Additions with average activity were MgO, $K_2O$, $SiO_2$, and BaO. Additions that were not very active were NiO, $ZrO_2$, and CeO. The intensity of the preliminary electronic interactions between ions or surface atoms of the additions and the base oxide played a decisive role in fritting. (M.C.G.)

**22501** ACTIVATION ENERGIES FOR CREEP OF MONOCRYSTALLINE AND POLYCRYSTALLINE URANIUM BETWEEN 120 AND 650°C. Pierre Grenier, Jean-Pierre Andre, and Paul Lacombe (Ecole des Mines, Paris). Compt. Rend., 258: 3485-7(Apr. 1, 1964). (In French)

The activation energies for creep in monocrystalline and polycrystalline uranium were determined as functions of temperature. Between 325 and 415°C and 325 and 480°C, respectively, for polycrystals and monocrystals, the activation energies were constant and nearly identical (31,200 and 31,500 cal/mole), implying a single mechanism of deformation for both forms of uranium. Plateaus of activation energy were also observed between 520 and 660°C; but the values were 42,000 and 65,000 cal/mole, respectively, for the polycrystalline and monocrystalline forms. (D.C.W.)

**22502** A STUDY OF STRUCTURE IN THE MOLYBDENUM–NICKEL–BORON SYSTEM. P. T. Kolomytsev and N. V. Moskaleva (Zhurkovskii Engineering Academy of Aviation, USSR). Dokl. Akad. Nauk SSSR, 154: 1120-2 (Feb. 11, 1964). (In Russian)

Mixtures of Mo, Ni, and up to 50% B were heated in an atmosphere of pure argon at 1000°C for a period of 100 hours. The phase composition was determined by x-ray and structural analyses with measurement of the microhardness. The structure shows the following constituents: a solid solution with $\alpha$-molybdenum as the base, a solid solution with $\gamma$-nickel as the base, an intermetallic compound NiMo as a $\delta$-phase, and a number of phases with binary borides or a ternary phase with the composition NiMoB as the base. The phases are designated as $\eta$ with the binary boride $Ni_3B$, $\theta$ with $Ni_2B$, $\lambda$ with $Ni_4B_3$, $\mu$ with NiB, $\beta$ with $Mo_2B$, $\epsilon$ with $Mo_3B_2$, and $\xi$ with the compound MoB as a base. The existence of these phase fields is indicated on an isothermal cross-section of the Mo–Ni–B system at 1000°C. Typical microstructures of various phases are presented. The microhardness was found to be 200 to 250 kg/mm$^2$ for the $\gamma$-nickel solid solution, 1000 to 1100 kg/mm$^2$ for the nickel boride phases, and 1500 to 1600 kg/mm$^2$ for the molybdenum boride phases and for the ternary phase having a composition of NiMoB. Thus, the microhardness of the boride phase does not necessarily increase with increasing boron content. (TTT)

**22503** RHENIUM — PREPARATION, PROPERTIES, AND USES IN HIGH-VACUUM TECHNOLOGY. W. Espe. Exptl. Tech. Physik, 12: 1-14(1964). (In German)

The properties of the high-melting metal rhenium, so far as these are of interest for vacuum technology purposes, are compiled as completely as possible. The possibilities for its use are discussed. In addition to unalloyed Re, because of the effects of Re on the tensile properties of tungsten, the W–Re alloy with about 27 wt % Re was studied for use as a construction material for high temperatures. The applicability of Re and Re alloys as base materials for indirectly heated oxide cathodes and in powder form as a matrix for distributed alkaline earth oxide cathodes was considered. For these purposes, in addition to unalloyed Re, an alloy of equal parts by weight of Re, W, and Mo appeared to be suitable. (tr-auth)

**22504** SATURATION MAGNETOSTRICTION CONSTANTS OF GADOLINIUM. J. Alstad and S. Legvold (Ames Lab., Ames, Iowa). J. Appl. Phys., 35: 1752-3 (June 1964). (IS-707)

The saturation magnetostriction constants of single-crystal Gd were measured from 4.2 to 340°K with a strain gage technique. A marked change in slope of $\lambda_A$ was observed near 220°K; this is the temperature region where the easy direction of magnetization in Gd shifts from the c axis to a cone around the c axis. The constant $\lambda_C$ shows a definite maximum near 130°K. (auth)

**22505** PRIMARY PYROELECTRIC EFFECT IN THE PZT 95/5 CERAMIC. J. L. Wentz and L. Z. Kennedy (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys., 35: 1767-70(June 1964). (SC-DC-3443)

An expression of the thermodynamic potential is examined in terms of the primary and secondary pyroelectric coefficients of a poled ferroelectric ceramic. Anisotropic expansion and zero electric field conditions are assumed. The pyroelectric coefficient is applied to the composition, $Pb(Zr_{0.95}Ti_{0.05})O_3$ (PZT 95/5) with 1 wt % of $Nb_2O_5$, for which a complete set of elastic, piezoelectric, thermoelastic, and pyroelectric coefficients were determined. A value of $-26.8 \times 10^{-9}$ C/cm$^2$–°C was found for the total pyroelectric coefficient of which $+3.77 \times 10^{-9}$ was contributed towards the piezoelectric or secondary effect; therefore, $-30.6 \times 10^{-9}$ C/cm$^2$-°C is reported for the primary pyroelectric coefficient for this material over the temperature range 25–50°C. (auth)

**22506** DISLOCATION ETCH PIT STUDIES IN ANNEALED AND DEFORMED POLYCRYSTALLINE NIOBIUM. P. R. V. Evans (Illinois Inst. of Tech., Chicago). J. Less-Common Metals, 6: 253-65(Apr. 1964).

An etch pit technique was used to study the dislocation structures in annealed polycrystalline niobium and after plastic deformation in tension at room temperature. The etch-pit density due to grown-in dislocations was found to decrease markedly with increasing annealing temperature. On tensile stressing, plastic flow was observed considerably below the upper yield point, and evidence of enhanced slip activity at grain boundaries suggested that most dislocation sources were located in these regions. The spacing of etch pits along individual slip planes were generally irregular but classical type dislocation pile-ups against grain boundaries were sometimes detected in the microstrain region. The grown-in dislocations as revealed by etching did not appear to participate in yielding, probably because they were too strongly locked by interstitial impurities. Many aspects of the etch pit patterns seen in

niobium were similar to previous observations made on Fe–Si alloys. (auth)

**22507** THE EFFECT OF HEAT-TREATMENT ON THE MECHANICAL PROPERTIES OF SOME COMMERCIAL BERYLLIUM. A. W. Jones and R. T. Weiner (United Power Co., Erith, Kent. Eng.). J. Less-Common Metals, 6: 266-82(Apr. 1964).

The effects of heat-treatment in the range 650–950°C for times between half-an-hour and 500 hr on the tensile properties under fast strain rates at 600°C of a batch of hot-pressed and warm-extruded virgin Brush QMV beryllium was studied. The creep properties of this material were also investigated in the range 500–600°C in the as-extruded condition and after heat-treatments at 950 and 700°C. Metallographic and x-ray techniques were used to follow changes of structure and constitution brought about by heat-treatment and by strain. Heat-treatment at low temperatures was found to increase the ductility at fast strain rates but decrease the creep strength, while heat-treatment at high temperatures was found to decrease the ductility at fast strain rates and increase the creep strength. Heat-treatment had no effect on tensile strength or on creep ductility. The results are attributed to a precipitation phenomenon involving intermetallic phases, which were identified by x-ray-diffraction methods, and to the presence of oxide particles within the grain boundaries. (auth)

**22508** THE ELECTRICAL RESISTIVITY OF SOLID AND MOLTEN URANIUM–CHROMIUM EUTECTIC. D. M. Provow and R. W. Fisher (Ames Lab., Ames, Iowa). J. Less-Common Metals, 6: 313-21(Apr. 1964). (IS-650)

The electrical resistivity of solid uranium –4.97 wt % chromium eutectic was determined from room temperature to its melting point of 870 ± 3°C and as a liquid from its melting point to 1000°C. The measurements were obtained in a vacuum by the use of the standard four probe method with current reversal. The electric resistivity values obtained from the solid eutectic by the use of two methods were in good agreement. The temperatures for the $\alpha$ to $\beta$ and $\beta$ to $\gamma$ phase transitions were 652 ± 2 and 756 ± 2°C, respectively. The drop in resistivity at these transitions was 1.8 for the former and 1.0 for the latter. A comparison of the eutectic with pure uranium showed a reduction in the temperature of the phase transitions of the alloys and in the magnitude of the drop in resistance. Tantalum was used successfully to contain the molten alloy at these temperatures. The electrical resistivity values of the molten alloy were 73.0 and 74.6 microhm-centimeters for 900 and 1000°C, respectively. The increase in resistivity of the eutectic from the solid to the molten state was 12.7 microhm-centimeters. (auth)

**22509** THE Sc–Gd SYSTEM. B. J. Beaudry and A. H. Daane (Ames Lab., Ames, Iowa). J. Less-Common Metals, 6: 322-5(Apr. 1964). (IS-690)

The scandium–gadolinium system, studied by thermal and x-ray methods, is characterized by complete solid solubility in the low temperature hexagonal form and in the high temperature bcc form. There are minima in both the solidus and in the temperature of transition from hexagonal to bcc. The former occurs at 65 at.% Gd and 1275°C, while the latter occurs at 55 at.% Gd and 1125°C. (auth)

**22510** THE DIMENSION AND STRUCTURE CHANGING EFFECT BY THERMAL CYCLING IN CUBIC AND NON-CUBIC METALS ESPECIALLY IN URANIUM. I. Quaeck (Zentralinstitut für Kernforschung, Rossendorf, Ger.). Kernenergie, 7: 133-8(Mar. 1964). (In German)

Thermal cycling treatments and their results on tin, lead, zinc, cadmium, aluminum, copper, nickel, uranium, Armco-iron, copper-zinc, and aluminum-zinc; oriented growth in uranium; structural changes in uranium; means for reducing the effects of thermal cycling on uranium (by alpha-beta phase transformation); thermal cycling behavior of uranium alloys; and mechanism of alpha-phase uranium growth upon thermal cycling are discussed and reviewed. (P.C.H.)

**22511** PROPERTIES OF MOLYBDENUM. HOW DUCTILE IS MOLYBDENUM TUBING? Laurence C. Shaheen (Super Tube Co., Norristown, Penna.). Metal Progr., 85: No. 5, 112-14(May 1964).

Properties of Mo tubing for missile, aircraft, and nuclear applications are discussed, along with the disadvantages of Mo tubing. The disadvantages include catastrophic oxidation above 1500°F, brittle welds, notch sensitivity, limited size range, difficulty in holding tolerances and concentricity, and comparative brittleness. For all practical purposes, the last four disadvantages no longer exist. Investigations under way appear to indicate that molybdenum tubes can be protected from rapid oxidation by silicide coatings. As for weld brittleness, the problem can be bypassed. When ductility is important, Mo tubing should be brazed rather than welded. Other properties of Mo tubing are also discussed. (P.C.H.)

**22512** PROPERTIES OF MOLYBDENUM. HOW STRONG IS MOLYBDENUM SHEET? Alan K. Hegedus (General Electric Co., Cleveland). Metal Progr., 85: No. 5, 115-17(May 1964).

Extensive tests were made on Mo sheet to determine its tensile properties at elevated temperatures. Below 3000°F the strain rate was held at a nominal 0.005 in. per in. per min through yielding, raising it to 0.05 through fracture. Above that temperature, the latter rate was used for the entire test cycle. In a series of tests for strain rate sensitivity, it was found that strength increased moderately as the rate was varied from 0.005 to 1.0 in. per in. per min. When Mo sheet is cold rolled, a wrought or fibrous microstructure is produced. This structure becomes unstable above about 1800°F and recrystallizes. Several characteristics of the structure affect tensile properties above 2500°F, although they are more of academic than practical significance. Data are tabulated. (P.C.H.)

**22513** BERYLLIUM ADDITIVES FOR CAST ALLOYS. D. Bodene (Beryllium Corp., Reading, Penna.). Metall, 18: 244-6(Mar. 1964). (In German)

The use of beryllium as a component in alloys to improve their casting properties is discussed. Melting and working of aluminum and magnesium alloys and the effects of beryllium additions are described. Metallurgical aspects of the effects of beryllium on these and other alloys are outlined. (M.C.G.)

**22514** EQUILIBRIUM CONCENTRATION OF POINT DEFECTS IN SODIUM METAL. G. A. Sullivan and J. W. Weymouth (Univ. of Nebraska, Lincoln). Phys. Letters, 9: 89-90(Apr. 1, 1964). (TID-20254)

Simultaneous length and x-ray-diffraction lattice parameter measurements on sodium metal single crystals were made from –20 to 96°C and expansion curves were prepared. The values derived from these measurements for the net vacancy concentration at the melting point and the energy of formation of vacancies are tabulated. (L.B.S.)

**22515** INTERSTITIALS AND VACANCIES IN $\alpha$ IRON. R. A. Johnson (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 134: A1329-36(June 1, 1964). (BNL-7710)

The migration energies and atomic configurations for mono- and di-interstitials and mono- and di-vacancies in $\alpha$

iron were calculated using a classical model. About 530 atoms surrounding the defect were treated as individual particles, each with three degrees of freedom, while the remainder of the crystal was treated as an elastic continuum with atoms embedded in it. A two-body central force was devised with matched and elastic moduli, was sharply repulsive at close separation, and went to zero midway between the second and third neighboring atoms. Configurations were found by choosing a starting configuration roughly approximating the situation under consideration and successively adjusting the value of each variable occurring in the energy equation so that the magnitude of the generalized force associated with it was zero until equilibrium was reached. The energy calculations include changes in bond energy in the discrete region, energy in the elastic field, and work done against cohesive forces, but neglect changes due to the redistribution of electrons. Calculated activation energies for motion of mono- and di-interstitials and mono- and divacancies were 0.33, 0.18, 0.68, and 0.66 ev, respectively, and binding energies of di-interstitials and di-vacancies were 1.08 and 0.20 ev, respectively. The stable interstitial was a split configuration in which two atoms were symmetrically split in a ⟨1 1 0⟩ direction about a vacant normal lattice site, and the stable di-interstitial consisted of two parallel split interstitials at nearest-neighbor lattice sites with their axes perpendicular to the line joining their centers. In the vacancy configuration an atom was missing from a normal lattice site, and the divacancy consisted of two vacancies at second-nearest-neighbor lattice sites. (auth)

**22516** EFFECT OF ALLOYING ON THE THERMAL EXPANSION OF NIOBIUM. R. A. Ul'yanov, N. D. Tarasov, and Ya. D. Mikhaylov. Tsvetn. Metal., No. 5, 116-20(1963).

The coefficients of linear thermal expansion of Nb and its alloys and the temperature dependence of the coefficients were studied in vacuum (0.00005 mm Hg) at temperatures up to 1050°C. Test specimens 10 mm in diameter and 75 mm long were prepared from alloy ingots arc melted from vacuum-refined Nb powder 99.86% pure in an argon atmosphere, rolled into rods in vacuum at 1100–1350°C, and stress relieved at 1400°C for 40 hr in vacuum. Alloying elements were added in amounts up to the limits of their solubility in niobium to obtain single-phase alloys. Only in the cases of boron and lanthanum, whose solubilities in niobium are very low, did the alloys have a two-phase structure. The results of the study showed that, within the Nb-base solid-solution region, alloying elements with coefficients of linear expansion higher than that of Nb (Cr, Ti, Pd) increased the coefficient of linear expansion of Nb alloys, elements with lower coefficients (B, Zr, Si, Ir, Ta, Mo, W, and, particularly, Re) decreased it, and La, within the low concentrations studied (up to 0.4%), had practically no effect. The greater the difference between the coefficients of linear expansion of Nb and the alloying element and the higher the concentration of the latter, the more pronounced the effect. (A.I.D. Press)

**22517** DIFFUSION OF CERIUM INTO NICKEL AND MECHANICAL PROPERTIES OF Ce–Ni ALLOYS. U. K. Duisemaliev (Inst. of Metallurgy and Ore Enrichment, Academy of Sciences, Kazakh SSR). Zh. Neorgan. Khim., 9: 755-6(Mar. 1964). (In Russian)

An analysis was made of the microstructure, microhardness (Brinell) and electric conductivity of Ni–Ce alloys (with 0.05, 0.10, 0.15, 0.20, 0.30, and 0.50 Ce). The results showed that 0.05% Ce broke the nickel grain and formed a solid solution. Two-phase alloys form with an increase of Ce content. Additions of Ce do not affect its diffusion at room temperature. The maximum diffusion of Ce into Ni is reached at 1200°C (0.125 wt % Ce). Additions of Ce to Ni increased the strength of the alloy and 0.05% Ce improved Ni plasticity at room temperature. Small additions of Ce (to 0.1%) slightly improve the electric resistance of alloys; however, a further increase of Ce content to 0.5% does not affect the electric resistance. (R.V.J.)

**22518** PHYSICOCHEMICAL PROPERTIES OF CARBIDES FOR NUCLEAR APPLICATIONS. S. Langer (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.242-86 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964.

The physicochemical properties of the actinide and refractory carbides are reviewed, and the phase relations in systems composed of mixed actinide carbides, actinide carbides and graphite, and systems of the actinide carbides and the refractory carbides are discussed. The conflicting and anomalous data are discussed and the absence of important data is noted. The basic physicochemical properties of the carbides were analyzed with respect to their use as a reactor core material. The known phase equilibria were analyzed to predict the melting behavior of previously proposed reactor systems, and the potential of various combinations of the actinide and refractory carbides for high-powered burner or power-reactor systems was discussed. 84 references. (auth)

**22519** PROPERTIES OF SOME HIGH-TEMPERATURE CONTROL MATERIALS. B. Weidenbaum, E. W. Hoyt, D. L. Zimmerman, W. V. Cummings, and K. C. Antony (General Electric Co., San Jose, Calif.). p.314-44 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964.

Information obtained for the AEC Control Rod Materials Program is presented. Transition-metal borides, rare-earth borides, and rare-earth oxides were found to be the most applicable in high-temperature environments. (R.E.U.)

**22520** THE PROCESSING, PHYSICAL PROPERTIES, AND PERFORMANCE OF PYROLYTIC GRAPHITE COATED $UC_2$. R. L. Finicle and S. A. Taylor (Union Carbide Corp., Lawrenceburg, Tenn.). 24p. (CONF-117-43)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Correlation of existing data provided sufficient information to postulate a mechanism of deposition for the coating of a particle system with pyrolytic graphite. The fundamental difference between the massive substrate and particle systems i etric. In the massive substrate system under a given of conditions the substrate encounters essentially a constant atmosphere while in the particle system a definite atmospheric gradient is experienced by the particles. This gradient actually results in a two phase atmosphere and the condition of these phases greatly influences the microstructure and physical properties of the deposit. Data from past experience and the literature concerning the deposition of pyrolytic carbon and graphite on massive substrates is presented, which influenced the selection of initial operating conditions and/or serves as an aid in explaining the deposition mechanism. The processing of two basic coating types are discussed including some physical properties and performance data. Included

also is the argument used in the justification and design of the duplex coating. (auth)

**22521** AN EXPLANATION OF MICROSTRUCTURES IN THE TANTALUM–CARBON SYSTEM. G. Santoro and H. B. Probst (Lewis Research Center, Cleveland). 19p. (CONF-174-12)

From 12th Annual Conference Application of X-ray Analysis, Denver, Aug. 1963.

Microstructures existing in the C–Ta system are shown to be the result of precipitation processes. Their characteristic appearance is accounted for by a precipitation model based on the geometries of the crystal structures involved. It is postulated that the maximum solubility of C in $Ta_2C$ must decrease with decreasing temperature rather than remain constant as the presently accepted phase diagram indicates. No evidence for a eutectoid decomposition of $Ta_2C$ was found. Tantalum can precipitate from $Ta_2C$ giving a unidirectional Widmanstatten structure; however, $Ta_2C$ precipitation from Ta is random apparently because of the inability of $Ta_2C$ to distort and maintain coherency with the Ta matrix. (P.C.H.)

## Radiation Effects

**22522** (CONF-504-1) COATED-PARTICLE FUELS FOR GAS-COOLED REACTORS. R. W. Dayton (Battelle Memorial Inst., Columbus, Ohio). [1963]. Contract W-7405-eng-92. 8p.

From American Power Conference 26th Annual Meeting, Chicago, Apr. 1964.

Ceramic coated-particle fuel materials were found to offer great promise for gas-cooled reactors, and are being studied intensively for such application. Research showed how to design and fabricate coated-particle fuels that will maintain their integrity for long periods of time. Materials presently available will retain fission gases and most other fission products at high temperatures to high burnup of the fuel. Loss of certain volatile fission products through pyrolytic-carbon coatings is being investigated intensively. Another problem under study is the weakness of beryllia coatings. It was concluded that good radiation performance is possible with alumina-coated and pyrolytic-carbon-coated fuel particles. (auth)

**22523** (CRFD-1179) TREFOIL BUNDLES OF NPD 7-ELEMENT SIZE FUEL IRRADIATED TO 9100 MWd/tonne U. A. S. Bain, J. Christie, and A. R. Daniel (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 1964. 70p. (AECL-1895)

NPD prototype elements (1 in. OD, 19 in. long) were assembled into trefoil bundles and irradiated in the X-5 pressurized-water loop of NRX. The first tests were for only a few weeks but showed that elements made by sheathing $UO_2$ pellets in Zircaloy-2 behaved well under irradiation; later similar elements were irradiated for 18000 hours to a burnup of 9100 Mwd/ton U at $\int kd\theta = 40$ W/cm. The dimensional stability of all the elements was good. Only those subjected to long irradiation showed progressive diametral increases, and these were attributed to relocation of the $UO_2$ during interim inspections. Length measurements demonstrated that pellet end-dishing is effective in controlling axial expansion, but that for a given depth of dishing the amount of expansion depends on the shoulder width. The extent of grain growth in the $UO_2$ was compatible with previously reported results when the duration of irradiation, density of the fuel, and variations in growth characteristics of the different batches of $UO_2$ are considered. The elements taken to high irradiation released up to 135 ml of fission-product gases, which is 27% of the amount formed. The transverse tensile strength of ring samples from the Zircaloy-2 sheaths increased from 75000 to 95000 lb/in$^2$ at room temperature, but the ductility dropped. The completely brittle fracture of some rings was due to $ZrH_2$ precipitation. The failure of one element was caused by increased stress due to a higher heat rating, combined with low ductility of the Zircaloy-2 resulting from radiation damage and with precipitation of $ZrH_2$ because of a lower coolant temperature. The fission-product release from the split was not excessive, and the element was easily withdrawn from the loop after operating at full power for four days from the time of the failure. (auth)

**22524** (EURAEC-874) MICROGRAVIMETRIC INVESTIGATION INTO THE MECHANISMS OF CORROSION OF REACTOR MATERIALS IN THE PRESENCE OF NUCLEAR RADIATION. Final Report. (Battelle Institut e.V., Frankfurt am Main). [1962]. Work performed under United States–Euratom Joint Research and Development Program. Contract 071-61-12-RDD. 24p.

The corrosion kinetics of pure iron, 18/8 stainless steel, and zirconium were investigated by microgravimetry in the presence and in the absence of $\beta$ radiation. Corroding atmospheres were oxygen and water vapor at pressures below 1 atmosphere. The radiation source was 30-c $^{90}Sr$–$^{90}Y$; the absorbed dose rate amounted to approximately $10^5$ rad/hr. No significant difference in corrosion kinetics was observed with and without radiation. With pure iron in oxygen at room temperature the corrosion rate was less than $1.5 \times 10^{-9}$ g/cm$^2$ ·hr. At 260°C with pure iron, stainless steel, and zirconium in oxygen and water vapor the corrosion proceeded according to the equation $g = A \cdot t^n$ where g = weight gain, A = a constant, t = time, and the exponent n ranges between 0.5 and 0.3. The corrosion mechanism of iron at intermediate temperatures (about 200°C) seemed to differ from that at high temperatures (e.g. 800°C) and low temperatures (room temperature and below). Also in a few discontinuous experiments at a radiation dose rate of about $10^4$ rad/hr (pure iron and zirconium at 260°C, 1 atm $O_2$ and 15 mm Hg $H_2O$), no radiation effect was observed. (auth)

**22525** (FZK-159-1) RADIATION EFFECTS INVESTIGATION OF SELECTED TRANSDUCERS AND MATERIALS FOR NERVA PROGRAM. VOLUME I. 150°F IRRADIATION. R. D. Crabtree and G. A. Wheeler (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Apr. 26, 1963. Subcontract NP-8. For Aerojet-General Corp., Azusa, Calif. 99p.

The performance of selected transducers was evaluated during reactor irradiation at temperatures of from 150 to 220°F. The transducers consisted of platinum-resistance thermometers, strain-gage and potentiometer-type pressure transducers, accelerometers, and high-temperature strain gages. A stimulus, automatically cycled, was applied to all transducers while they were exposed to a maximum of $8.92 \times 10^{15}$ n/cm$^2$ (E > 2.9 Mev) and $5.62 \times 10^{10}$ ergs/g(C) gamma dose. Prior to irradiation the primary coil of one accelerometer opened because of excessive temperature. (auth)

**22526** (HW-SA-3128) THE IRRADIATION PERFORMANCE OF $ZrO_2$–$PuO_2$ NUCLEAR FUEL. M. D. Freshley and D. F. Carroll (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 8, 1963. Contract AT(45-1)-1350. 16p. (CONF-187-73)

From American Nuclear Society Meeting, New York, Nov. 1963.

$ZrO_2-PuO_2$ fuels exhibited satisfactory irradiation stability under the operating conditions to which these samples were exposed in the ETR. The fuels were resistant to in-reactor hot water corrosion. Post-irradiation x-ray diffraction examinations showed primarily monoclinic $ZrO_2-PuO_2$ solid solution and face-centered cubic solid solution, i.e., no change. A precipitated white material was observed. (auth)

**22527** (NASA-CR-40) PROTON DAMAGE IN SEMICONDUCTOR DEVICES. D. M. Arnold, J. A. Baicker, H. Flicker, D. A. Gandolfo, J. R. Parker, J. Vilms, and J. Vollmer (Radio Corp. of America, Camden, N. J.). Apr. 1964. Contract NAS1-1654. 72p.

Changes in electrical characteristics of transistors due to proton damage were interpreted in terms of fundamental changes in the semiconductor crystal structure. The displacement production rate in silicon was calculated for proton energies from 1.5 to 180 Mev. Up to 100 Mev this displacement production rate was found to agree well with the experimentally determined rate of incidence of electrical damage in solar cells. This indicated that the number of electrical defects is directly proportional to the number of lattice displacements. Above 100 Mev, displacements resulting from nuclear reactions became more important. The displacement production rate resulting from neutron bombardment was also calculated. The number of electrical defects associated with transmutated atoms produced by a proton at a given energy was found to be significantly smaller than that resulting from displacements, indicating that the latter is the more important factor in determining permanent device damage in proton irradiation. Currents generated in transistors as a result of proton-induced ionization and electron excitation were found to be unimportant at the flux rate encountered in the Van Allen radiation belts. An attempt was made to extend the method of predicting proton damage in silicon semiconductor devices to include predictions for germanium devices. It was found that, as in the case of silicon, suitably modified neutron irradiation data could be used to approximate proton radiation effects on germanium transistors. (M.C.G.)

**22528** (ORNL-3591(p.128-40)) IRRADIATION BEHAVIOR OF HIGH-TEMPERATURE FUEL MATERIALS. O. Sisman and J. G. Morgan (Oak Ridge National Lab., Tenn.).

Studies of the release of fission gas from pyrolytic-carbon-coated carbide fuel particles during irradiation were continued. Duplex and triplex types of coatings on uranium and uranium–thorium carbide particles were irradiated at temperatures up to 2500°F and heavy-metal burnups up to 20 at. %. The fission-gas release rates were determined by measuring the krypton and xenon isotopes over a range of temperatures and burnups. The fuel was also subjected to a series of thermal cycles, some of which were in the phase transformation range. The condition of the fuel after irradiation was determined by metallographic examination. Postirradiation anneal tests up to 3250°F were performed on the same particles for which fission-gas release rates were measured during irradiation. Pyrolytic-carbon-coated $UC_2$ and $(U,Th)C_2$ particles dispersed in graphite were examined after irradiations at 1500°F. The elements, as $1\frac{1}{2}$-in. spheres, were made with both fueled and unfueled shells. Some were in the form of fuel cylinders sealed in graphite spheres. In general, the spheres remained dimensionally stable and contained no macrocracks. Weight changes were small, and compressive and impact strength was unchanged. Fission product release was low. Most of the 36 EGCR prototype capsules, which were irradiated and examined, performed satisfactorily. However, eight of these capsules failed in various ways. Detailed examination showed that each of these failures was associated with, and in most cases was a direct result of, conditions outside those of the EGCR design. Three types of capsule failure, causing a loss of fission gas, were found: severe cladding fractures were a result of stresses caused by expansion of the $UO_2$ coupled with nitride embrittlement of the cladding; minor cladding fractures occurred at depressions in the cladding, which were caused by a lack of internal support for the cladding; in one case, a pressure transducer fractured. Adverse effects, similar to but less severe than those in the failed capsules, were observed in several of the capsules; which performed satisfactorily. (auth)

**22529** (ORNL-3591(p.147-55)) EFFECT OF RADIATION ON CERAMIC MATERIALS. (Oak Ridge National Lab., Tenn.).

Four types of sintered BeO compacts (two grain sizes and two densities) were irradiated at 100, 650, and 1100°C. Gross damage (fracturing and powdering) and volume expansion decreased with increasing temperature and increased with increasing fast-neutron dose. At 650 and 1100°C, BeO of low density and fine grain size clearly withstood irradiation better than the other three types. The primary manifestation of damage was grain-boundary separation, but considerable transgranular fracture was seen in photomicrographs of large-grained BeO. Irradiated single crystals of BeO showed volume increases, which decreased with increasing temperature, but which were considerably less than volume increases in compacts similarly irradiated. Optical studies and density measurements of single crystals irradiated at 650 and 1100°C indicated that agglomerates of defects, aligned in planes perpendicular to the c axis, produce a substantial anisotropic crystal expansion beyond that due to the anisotropic lattice expansion. This combined anisotropic expansion, generally believed to produce grain-boundary separation at low temperatures (~100°C), may also be the dominant mechanism above 650°C. The temperature and energy of recrystallization of irradiated steatite, cordierite, forsterite, and lava A are being determined by thermal analysis. A twin-crucible apparatus, which was built, has several-fold greater sensitivity in the temperature range below 600° than the single-crucible apparatus used previously. The recyrstallization of irradiated steatite was examined by x-ray and petrographic methods. The annealing of the radiation change in several other ceramic materials is being studied by thermal conductivity measurements. Equations were derived for calculating elastic constants from the flexural and torsional resonant frequencies of a supported cantilever plate. (auth)

**22530** (ORNL-3591(p.175-81)) FISSION PRODUCTS RELEASED DURING IN-PILE DESTRUCTION OF REACTOR FUELS. W. E. Browning, Jr., C. E. Miller, Jr., B. F. Roberts, R. P. Shields, and W. H. Montgomery (Oak Ridge National Lab., Tenn.).

In-pile experiments are being continued in the Oak Ridge Research Reactor (ORR) to study the characteristics and behavior of fission products released by melting or vaporizing miniature stainless-steel-clad $UO_2$ fuel elements in a helium atmosphere or by burning pyrolytic-carbon-coated $UC_2$–graphite fuel elements in air. Studies were made of the effects of gas velocity on fission product release and behavior, of the fine-particle and vapor forms of released

fission products, of the particulate material collected by filters, of the distribution of released fission products, and of the fractionation of fission products. In the experiments in which pyrolytic-carbon-coated uranium carbide–graphite fuel was burned in air in the ORR, a large fraction of less volatile fission products was retained in the unburned fuel. The release of Sr, Zr, Ba, Ce, and U from the high-temperature zone of the furnace was very low, but large fractions of I, Te, and Cs were released. Forty percent of the ruthenium was released from the furnace in one experiment and 5.7% in the other. The side of the fuel specimen with the least amount of uranium carbide burned preferentially, indicating that the graphite matrix oxidized more rapidly than the pyrolytic-carbon-coated fuel particles. This belief was also supported by discovery of undamaged fuel particles that fell away from the burning fuel specimen. In experiments performed to study the effect of helium flow rate on fission product release, the flow was increased sixfold over that employed in previous experiments, with other conditions remaining unchanged. The increased helium flow rate lowered the maximum temperature of the fuel. At a given temperature, release of fission products generally from the fuel itself and release of the more volatile isotopes, I, Te, and Cs, from the high-temperature zone of the furnace did not appear to be affected by an increased flow rate, but release of the less volatile isotopes from the furnace increased fourfold with the sixfold increase in flow rate. The diffusion tube deposit indicated that fission products occurred in the vapor form in the experiment with the highest flow rate, rather than as particles with an average diameter of about 25 Å, which were observed in the other experiments. The distribution of released fission products and uranium deposited from a gas flowing laminarly through a diffusion tube was analyzed to yield information about vapors, gas-borne particles in the range of 10 to 100 Å in diameter, and the amounts of released material associated with these forms. In most of the experiments the data indicate that particles having an average diameter of about 25 Å were released. Considerable amounts of released $^{131}I$, $^{132}Te$, and $^{137}Cs$ were always carried by these fine particles. Smaller amounts of released $^{89}Sr$ and $^{140}Ba$, uranium and $^{106}Ru$ were carried by these particles in the $UO_2$ melting experiments, but these substances did not appear to be carried by particles of this size in the uranium carbide–graphite burning experiments. In the case of the $UO_2$ melting experiments, $^{95}Zr$ and $^{144}Ce$ were very seldom carried by particles of this size, but they were usually carried by these particles in the uranium carbide–graphite burning experiments. Besides being carried by these small particles, the various fission products and uranium were probably also carried by larger particles, which pass through the diffusion tube and are retained on the filters. In the experiment with the highest gas flow rate, considerable amounts of released $^{131}I$, $^{89}Sr$, and $^{140}Ba$ and smaller amounts of $^{132}Te$ and $^{137}Cs$ were carried as vapors. However, only small amounts of $^{95}Zr$, $^{144}Ce$, $^{106}Ru$, and uranium were carried as vapors. The appearance of vapor forms of these materials at higher gas velocities could be caused by their more rapid transport from the release site and their greater dilution, both of which would reduce the tendency for particle formation. The sweep gas from the in-pile fuel melting and burning experiments was passed through a series of filters to obtain information about the particulate material which is formed. Most of the filters, especially those initially encountered by the gas stream, were too radioactive for electron microscopy, but data on a few filters were obtained. Particles ranging in size from 0.015 to over 1 μ occurred downstream from the initial filter in the $UO_2$ melting experiments. Median particle diameters ranged from 0.01 to 5 μ in the corresponding filters in the uranium carbide–graphite burning experiments. In the $UO_2$ experiments agglomerates of like-sized particles and particles of various densities were observed. In some cases particles were spheres and in others they appeared to be platelets. The distribution of the released fission products and uranium between the various parts of the in-pile fuel destruction assemblies was determined by radiochemical and chemical analysis. In a typical experiment, 60 to 90% of the more volatile fission products, I, Te, and Cs, escaped from the high-temperature zone of the furnace and were distributed more or less evenly between the cold stainless steel enclosure of the furnace, the diffusion tube, and the roughing filter. A Gelman HV-70 filter collected about 3% of the inventory of iodine and cesium. Approximately 3% of the iodine, 4% of the cesium, and less than 0.5% of the tellurium were found downstream of the HV-70 filter. Four percent of the ruthenium escaped from the hot zone, and half of that was stopped by the HV-70 filter. Most of the remainder was found on the membrane filter or its support. The other fission products (Sr, Ba, Zr, and Ce) and uranium were released from the hot zone in amounts of 1% or less. Not more than 0.25% of the inventory of these materials was found downstream of the HV-70 filter. The filters exhibited a rather low percentage of effectiveness against the materials which arrived at their faces, but the materials which penetrated were very small fractions of the total inventory. In fission product release experiments, fission products appeared in varying proportions in various locations, and sample compositions were, in general different from those predicted for normal fission yields. This fractionation occurred because differences in the physical and chemical characteristics of individual fission products resulted in differences in their behavior in release, transport, or deposition processes. Fractionation of fission products is expected to occur similarly in reactor accidents. A study was made in which the fractionation predicted by several different models was compared with experimental results. The vapor transpiration model, in which fractionation is brought about by evaporation of the fission products from the fuel and by their removal by a carrier-gas stream, gave the most satisfactory agreement with the data from the in-pile fission product release experiments. The theory predicted a straight line when certain ratios of fission products were plotted against each other on log-log coordinates. The theory, with information from the literature on vapor pressures of fission product materials and experimental data on the amounts vaporized, was used to predict successfully the proportions of fission products in various experimental samples. This appeared to validate the assumptions of the model and to identify the mechanism of fractionation. The heats of vaporization and thus the chemical forms of the fission products during vaporization are also identified in the same operation. In most of the experiments with stainless-steel-clad $UO_2$, the Sr, Ba, and Zr were vaporized in the metallic form; however, in one they were in the oxide form. (auth)

**22531** (ORNL-TM-742) BEHAVIOUR OF BeO UNDER NEUTRON IRRADIATION. G. W. Keilholtz, J. E. Lee, Jr., R. E. Moore, and R. L. Hamner (Oak Ridge National Lab., Tenn.). [Dec. 11, 1963]. Contract W-7405-eng-26. 23p. (CONF-281-49)

From International Conference on Beryllium Oxides, Sydney, Oct. 1963.

Four types of cylindrical BeO specimens which consisted of two densities (2.7 and 2.9 g/cm$^3$) and two grain sizes (~22 and 34 to 72 μ) were irradiated at 100, 650, and 1100°C to fast-neutron doses ranging from 0.3 to $4.2 \times 10^{21}$ nvt. Gross damage decreased with increasing temperature, but even at 1100°C severe fracturing occurred in many samples exposed to doses exceeding $2 \times 10^{21}$ nvt; however, no powdering occurred even at $4.2 \times 10^{21}$ nvt. In irradiations at 650°C there was fracturing at $1.5 \times 10^{21}$ nvt and powdering of many of the specimens at high doses. At 100°C, severe fracturing occurred above $1 \times 10^{21}$ nvt with powdering of specimens irradiated to doses above $2 \times 10^{21}$ nvt. The BeO type of low density and fine grain size withstood irradiation better than the other three types at 650 and 1100°C. There was no significant difference among the four types at 100°C. Volume increase, which appeared to be a good criterion of fast-neutron damage, was proportional to the neutron dose at each temperature, and increased with decreasing temperature. At 1100°C, low-density fine-grain BeO expanded the least (~1.5% at $4.2 \times 10^{21}$ nvt), and high-density large-grain BeO expanded the most (~3.5% at $4.2 \times 10^{21}$ nvt). There were no definite significant differences in volume increase among the four types of BeO at 100 and 650°C. The volume of specimens irradiated 650°C increased approximately linearly from ~2% at $0.8 \times 10^{21}$ nvt to ~6% at $2.2 \times 10^{21}$ nvt; the volume at 100°C increased from 1.5% to 6.0% over the dose range 0.4 to $1.8 \times 10^{21}$ nvt. Grain-boundary separation can account for most of the changes in physical properties of irradiated BeO, but a considerable amount of transgranular fracture was also seen in photomicrographs of the large-grained (~70 μ) BeO. The greater damage to large-grained BeO may result from wider separations between grains as well as more transgranular fracture. More space for crystal expansion may be the explanation for the beneficial effect of low density. Single crystals irradiated at 650°C fractured easily along the basal planes. These crystals had a dark banding, parallel to the basal planes, which optical and x-ray diffraction results indicated consisted of defect agglomerates with properties similar to amorphous BeO. Density measurements showed that the volume increases of the crystals were several times greater than those calculated from the lattice parameters. Volume increases of 0.9% and 3.9% were observed for crystals irradiated at $1.1 \times 10^{21}$ and $4.1 \times 10^{21}$ nvt, respectively. Anisotropic expansion for crystals in randomly oriented compacts is generally accepted as the mechanism for causing grain-boundary separation at low temperatures and low neutron doses. Because lattice parameter expansion, which is anisotropic, is greatly reduced at high temperatures, the build-up of helium pressure at grain boundaries was seriously considered as the dominant mechanism at high temperatures and high neutron doses. Single-crystal studies indicated, however, that defect agglomeration produces a large anisotropic crystal expansion at temperatures at least as high as 650°C. Accordingly, anisotropic expansion may be the dominant mechanism at high temperatures as well as low temperatures. (auth)

**22532** (ORNL-TM-849) THE EFFECT OF GAMMA RADIATION ON THE THERMAL CONDUCTIVITY OF ALUMINUM CORROSION PRODUCT FILMS. J. C. Griess, H. C. Savage, and J. M. Baker (Oak Ridge National Lab., Tenn.). Apr. 27, 1964. Contract W-7405-eng-26. 10p.

An experiment to determine the effects of gamma radiation on the thermal conductivity of corrosion product films (boehmite) formed on aluminum surfaces in water was completed. Within the limit of detection, doses of gamma radiation from a cobalt-60 source up to $1.7 \times 10^9$ rads had no effect on the thermal conductivity of the corrosion product. (auth)

**22533** (REIC-ACCESS-73) RADIATION EFFECTS INFORMATION CENTER MONTHLY ACCESSION LIST. Period Covered: March 1, 1964–March 31, 1964. Abstract No. 22919 to 23001. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Apr. 10, 1964. Contract AF33(615)-1124. 33p. (AD-434600)

Eighty-two abstracts of papers on radiation effects are presented under the following headings: metallic materials; ceramic materials; organic materials; polymeric materials; inorganic materials; electronic materials; computers, and devices; facilities; space environment and effects on materials; experimental devices and techniques; and miscellaneous. (M.C.G.)

**22534** (SC-R-64-124) THE EFFECT OF RADIATION ON THE MECHANICAL PROPERTIES OF POLYMERS, UNCLASSIFIED LITERATURE 1955 TO OCTOBER 1963. A Bibliography. R. K. Traeger (Sandia Corp., Albuquerque, N. Mex.). Mar. 1964. Contract [AT(29-1)-789]. 38p.

Approximately 380 references are given to books, reports, and U. S. and foreign journals published from 1955 to 1963. Neutron, gamma, x-ray, electron, uv, and mixed (or pile) radiations are considered. References are listed under individual polymer types. General reviews, books, and effects on dynamic mechanical properties are given separate headings. (P.C.H.)

**22535** (SC-TM-64-69) PREDICTING CURRENT GAIN DEGRADATION IN NPN SILICON TRANSISTORS AFTER IRRADIATION BY HIGH-ENERGY NEUTRONS. Jerry A. Hood (Sandia Lab., Albuquerque, N. Mex.). Mar. 1964. Contract AT(29-1)-789. 78p.

The permanent degradation of the electrical characteristics of NPN silicon planar transistors caused by neutron radiation, the dependence of the degradation on the device design, and electrical testing methods used to determine the transistor design parameters which affect the radiation tolerance are described. From this information, a testing procedure was developed, which predicts the transistor current gain as a function of total integrated neutron flux. (auth)

**22536** CRYSTALLOGRAPHIC IMPLICATIONS OF EPR IN NEUTRON-IRRADIATED DIAMOND. R. M. Denning (Univ. of Michigan, Ann Arbor) and Edward H. Poindexter. Am. Mineralogist, 49: 277-85(Mar.-Apr. 1964).

Diamonds irradiated with fast neutrons were studied by electron paramagnetic resonance (EPR). The concentration of free spins and the line width of the signal were studied as a function of total irradiation, before and after heat treatment. The signal intensity is proportional to total integrated radiation to $10^{18}$ nvt (fast). Over a thousand free spins are created for each primary neutron collision with a carbon atom. The EPR intensity decreases rapidly after heat treatment. The line widths are independent of radiation up to $10^{17}$ nvt, and they also decrease markedly after heat treatment. The EPR phenomena in irradiated diamond are quite different from those in graphite. It is suggested that highly irradiated diamond is a mosaic of microcrystals separated by a cement of damaged, amorphous, diamond-like glass. The conclusions of the EPR study support similar conclusions based on cleavage surface optical reflections and differential grinding hardness. (auth)

**22537** RADIATION DAMAGE AND ANNEALING OF CARRIER LIFETIME IN SILICON. Kenji Matsuura

(Sumitomo Electric Industries Co., Ltd., Japan) and Yoshio Inuishi. Denki Gakkai Zasshi, 83: 1354-61(Aug. 1963). (In Japanese)

Radiation damage and its annealing process in various kinds of Si crystals irradiated with $^{60}$Co $\gamma$ rays and pile neutrons were investigated by measuring the change in minority carrier lifetime by a microwave method. It was confirmed that radiation damage and its annealing are very sensitive to impurities such as O and Ni and to dislocations. The interaction between radiations introduced vacancies and various other imperfections such as impurities, and dislocations were found both in the introduction and the annealing curve. "Reverse annealing" in pulled Si was ascribed to the formation and dissociation of vacancy-oxygen complexes (A centers). Similar effects occurred in Ni-doped Si. Activation energy of the annealing was 1.0 ~ 1.2 ev and 0.7 ~ 0.8 ev for bulk and dislocation-enhanced annihilation respectively. The dissociation energy of A centers calculated from the annealing kinetics was 1.8 ev. The formation and dissociation of A centers were also deeply influenced by the irradiation time and dose rate. The depth of the recombination levels and the trap levels was estimated from temperature dependence of carrier lifetime and thermal release time. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**22538** COMPARISON OF SELF-IRRADIATION EFFECTS IN ALPHA PLUTONIUM ENRICHED AND UNENRICHED IN $^{238}$Pu. R. O. Elliott and C. E. Olsen (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 35: 1925-31(June 1964).

Self-damage accumulation at 22.5°K was studied in alpha plutonium enriched and unenriched in $^{238}$Pu. The enriched specimen was held at this low temperature for a period equivalent to about 14,000 h in terms of damage accumulated in the unenriched specimen. The resistivity of the enriched specimen increased to a maximum of 141.5 $\mu\Omega$-cm and then decreased gradually with additional time. The increase was attributed to self-irradiation damage consisting of interstitials and vacancies, and the decrease is discussed in terms of possible effects due to phase transformation, internal stresses, magnetic ordering, impurities, and clustering of defects. Annealing behavior differed widely in the two plutonium specimens studied, and this is also discussed. (auth)

**22539** IRRADIATION EFFECTS ON POLYMER BLEND. II. EFFECTS ON STRETCHED OR ROLLED MIXTURE OF POLYETHYLENE. Shozo Iida and Hiroshi Sakami (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 12: 540-3(Nov. 1963). (In Japanese)

Irradiation effects on a mixture of high- and low-density polyethylenes were studied by measuring the specific heat–temperature characteristics. It was found that the specific heat–temperature curve for the unirradiated polymer blend showed two peaks at the melting point of each polyethylene, and that for the sample irradiated at room temperature also showed two peaks; the sample irradiated in the molten state showed a curve with only one peak. From these findings it was concluded that the mixture unirradiated or irradiated at room temperature is blended heterogeneously, but the specimen irradiated in the molten state is blended homogeneously. Another method was used to obtain a homogeneous mixture without the thermal degradation that occurred in the previous method. That was to apply a room-temperature irradiation to the mixture elongated by stretching or rolling. Crystals composed of both polymers were formed by elongation, and this state was stabilized with crosslinking by irradiation. Then it showed only one peak of specific heat at the temperature between the melting point of both polymers. (Nucl. Sci. Abstracts of Japan, 3: No. 2(Apr. 1964))

**22540** SPLIT INTERSTITIAL CONFIGURATION INDUCED IN PEROVSKITE TYPE SINGLE CRYSTALS BY NEUTRON BOMBARDMENT. H. Weik (Univ. of Cincinnati). Phys. Letters, 9: 92-3(Apr. 1, 1964).

The structural changes of four main faces of fast neutron irradiated $SrTiO_3$ crystals were investigated. Laue patterns indicating the formation of split interstitials are shown. (L.B.S.)

**22541** RADIATION DAMAGE IN Si AND ITS ANNEALING PROCESSES. Toshikatsu Tanaka and Yoshio Inuishi (Osaka Univ.). Technol. Rept. Osaka Univ., 13: 247-59 (Oct. 1963).

The interactions between impurities such as oxygen and Frenkel defects introduced by $\gamma$ and neutron irradiation at room temperature were investigated mainly through Hall effect and lifetime measurements. Annealing behavior of A centers (vacancy-oxygen complexes) was found to be different from sample to sample. Annealing temperature increased with increasing A-center density. Several deep levels were also produced by irradiation. The annealing behavior of those deep levels was considerably different from that of A centers, being insensitive to dosage and sensitive to impurities such as Ni. The behavior of lifetime in high-resistivity samples was similar to that of the deep levels. Ni diffused to Si crystals acted as an acceptor level and caused negative annealing of deep levels. (Nucl. Sci. Abstracts of Japan, 3: No. 2, (Apr. 1964))

**22542** NUCLEAR MAGNETIC RESONANCE IN IRRADIATED RUBBERS. V. L. Karpov, N. M. Pomerantsev, and N. M. Sergeev (Karpov Inst. of Physics and Chemistry, Moscow). Vysokomolekul. Soedin., 5: No. 1, 100-7(Jan. 1963). (In Russian)

Samples of SKB (contains 60 to 70% 1,2-butadiene rubber, cleaned by repeated precipitations from benzol solution by methanol) and SKD (contains 90 to 95% of 1,4-butadiene) were irradiated by a $^{60}$Co source. The spectra of the irradiated rubbers consist of a narrow (0.2 gauss) and a broad (9.2 gauss) component. The intensity of the narrow line characteristic of the spectrum of the initial, unirradiated rubber diminished with increasing dosage. Simultaneously, the intensity of the broad line increased. When SKB was irradiated in a vacuum at 70 to 80 Mrad and SKD at 200 to 220 Mrad, the narrow line faded out almost completely. Irradiation in air was accompanied by analogous changes in the NMR spectrum of the rubber, but in this case the narrow line still could be observed clearly at dosages above 100 Mrad. A qualitative interpretation of the results is presented. (OID)

**22543** INFRARED ABSORPTION AND PHONON-FREE TRANSITIONS IN RADIATION-COLORED LiF. Wolf Von der Osten and Wilhelm Waidelich (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 178: 244-52 (1964). (In German)

Spectral positions, properties, and behavior of the lines and bands found in the infrared absorption of x-rayed LiF single crystals at 90°K are investigated. Thermal annealing and optical bleaching of the crystals give informations about the correlation of the lines and the bands. Both prove to be transitions in the same absorption center. This agrees well with the fact that the lines are due to phonon-free transitions in color centers, while the bands are broadened by multiphonon processes. For the thermal

annealing process of the infrared absorption a characteristic temperature of 420°K and an activation energy of 0.44 ev for the recombination process can be calculated by analyzing isochrone annealing curves. According to their similar behavior the infrared bands are compared with the R-center absorption. (auth)

**22544** INTRODUCTION OF INTERSTITIAL ARSENIC DONORS IN GERMANIUM BY THERMAL NEUTRON BOMBARDMENT. Herman Shulman and Samuel J. Moss. 10p. (CONF-481-15)

From American Physical Society Annual Meeting, New York, Jan. 1964.

Thermal neutron bombardment experiments were made on As-doped germanium to determine whether or not As is an interstitial donor and, if it is, the energy level of the donor states relative to the conduction band of the material. The first, and most apparent, result of the experiment was that the Hall voltage changed with time very rapidly and reached the turning point $7\frac{1}{2}$ hours after removal from the reactor. The number of electrons removed by virtue of the displacements resulting from recoils was determined from Hall coefficient measurements. The number of acceptors introduced (per $cm^3$) per absorbed thermal neutron (per $cm^3$) was, in three samples, 1.55, 1.6, and 2. Calculation of the position of the Fermi level places it between 0.012 and 0.013 ev below the conduction band between 17 and 22°K. (P.C.H.)

# METEOROLOGY

**22545** (AEEW-R-227) MODEL TESTS ON FLOW FROM A BUILDING VENTILATION STACK. A. L. Skinner (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Nov. 1962. 21p.

Wind tunnel tests were made on a model of a building for handling radioactive materials at the Atomic Energy Establishment, Winfrith. The object was to assess the minimum requirements for a stack that would effectively disperse the ventilation air clear of the building wind eddies and also avoid recirculation into the inlet grill. The factors of wind direction and speed, the detail design of the stack top, its height and the discharge velocity were studied, using still and ciné photography. The results suggested that just sufficient clearance of the plume could be expected for normal conditions with a stack height of 90 ft. This equals 1.7 times the height of the highest part of the roof or 2.25 times the average roof height. A high discharge velocity and a cone or ring at the stack outlet all gave a marked improvement in the flow. (auth)

**22546** (CONF-173-4) MAN-MADE IONIZED COLUMNS IN THE ATMOSPHERE — A NEW TOOL FOR METEOROLOGICAL RESEARCH. Harry Moses, Ronald L. Martin, Jacob Kastner, and Aaron J. Ulrich (Argonne National Lab., Ill.). Aug. 1963. Contract W-31-109-eng-38. 19p.

From American Meterological Society 44th Annual Meeting, Los Angeles, Calif., Jan. 1964.

The use of a high energy proton or electron beam, directed vertically to act as a probe for the study of atmospheric processes is proposed. An outstanding feature of such an atmospheric probe is its capability to ionize a column of air repeatedly in a few microseconds and in approximately the same place. Characteristics of a vertical proton beam which may be generated by the Zero Gradient Synchrotron are discussed, and calculations are presented to provide an estimate of the ion concentration as a function of height in the atmosphere. The potential uses of an atmospheric ionized column for meteorological research are discussed. Also presented is a method whereby a combination of the high energy particle beam and infrared techniques may be used to determine the air circulation within a thunderstorm. The possible uses of a high energy particle beam for aerospace sciences, such as the study of whistlers and electro-magnetic radiation phenomenon associated with the aurora and airglow are briefly discussed. (auth)

**22547** (ANL-Trans-12) THE DETERMINATION OF TURBULENT FLOWS OF MOMENTA, HEAT AND MOMENTA, HEAT AND MOISTURE FROM GRADIENT MEASUREMENT DATA. A. B. Kasanskii (Kasanskiy) and A. S. Monin. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Meteorol. i Gidrol., No. 12, 3-8(1962). 7p.

Principles and relations are presented for determining the vertical turbulent flows of heat, moisture, and momentum from measurements of the mean wind velocity, temperature, and humidity at some (usually two) heights in the ground air layer. (D.C.W.)

# PHYSICS

## General

**22548** (AD-414164) RESEARCH ON CESIUM VAPOR. Annual Report, May 1, 1962–May 1, 1963. A. O. Jensen (Electro-Optical Systems, Inc., Pasadena, Calif.). June 14, 1963. Contract Nonr-3805(00). 61p. (EOS-3130-Annual)

The results of an investigation into the absorption of resonance radiation in cesium vapor and the effect of resonance radiation on the ionization processes in cesium vapor plasmas are reported. A model for the dominant ionization processes is proposed that appears to be applicable to the cesium pressure range and other conditions found in cesium vapor thermionic converters. It was found that the atomic resonance absorption bandwidths at the 8521 and 8943 Å resonance lines are much greater than previously reported. A molecular absorption band near 7600 Å was also observed which can contribute significantly to the energy input to a cesium vapor plasma. At high cesium pressure (greater than 0.3 mm Hg) and emitter temperatures (greater than 1800°K) the absorption of resonance radiation may be the most significant energy input into a cesium vapor thermionic converter plasma leading to the formation of the cesium molecular ion as the dominant ionic species in the plasma according to the relationship: $Cs^* + Cs^*$ (heat of formation $Cs_2$) $\rightarrow Cs_2^+ + e$. (auth)

**22549** (AD-436274) LECTURES ON MAGNETOHYDRODYNAMICS. V. C. A. Ferraro (Illinois. Univ., Urbana. Coordinated Science Lab.). Mar. 1964. Contract DA-36-039-AMC-02208(E). 92p. (R-197)

Magnetohydrodynamic equations are developed and examined for numerous situations. Magnetohydrostatics, magnetohydrodynamic waves, and hydromagnetic stability are considered. Some astrophysical applications of magnetohydrodynamics are also discussed. (D.C.W.)

**22550** (HW-80020) PHYSICS RESEARCH QUARTERLY REPORT, OCTOBER–DECEMBER 1963. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 15, 1964. Contract AT(45-1)-1350. 59p.

Separate abstracts were prepared for the six sections of the report. (D.C.W.)

*For abstracts of individual sections see: 22335, 22705, 22849, 22850, 23012, and 23034.*

**22551** (LA-3007) AN UNCONDITIONALLY STABLE IMPLICIT DIFFERENCE SCHEME FOR THE HYDRODYNAMICAL EQUATIONS. James Turner and Burton Wendroff (Los Alamos Scientific Lab., N. Mex.). Oct. 1, 1963. Contract W-7405-eng-36. 45p.

Two hydrodynamical problems are solved. The first involves a shock wave, a contact discontinuity, and a rarefaction wave using an unconditionally stable finite difference scheme. The Courant condition is satisfied everywhere except in one zone behind the shock, where it is violated by factors of 10 and 100. The nonlinear difference equations are solved by Newton's method. The total number of Newton iterations to get to a certain time is apparently independent of the degree to which the normal stability condition is violated in the one zone. The second problem involves two rarefaction waves moving in opposite directions. One wave moves in a region where the Courant condition is violated by a factor of approximately two. The other wave moves in a region where the Courant condition is satisfied. Numerical results are compared with the analytical solution. An examination of several runs indicates one explicit time step is about five times as fast as one implicit time step. Therefore, use of the implicit method is indicated when the Courant condition is violated by a factor of 5 or more. (auth)

**22552** (LAL-1090) RAPPORT D'ACTIVITE, MAY 1, 1963–JANVIER 1, 1964. (Report of Activity, May 1, 1963-January 1, 1964). (Paris. Universite, Orsay. Ecole Normale Superieure. Laboratoire de l'Accelerateur Lineaire). Feb. 12, 1964. 52p.

Improvement and utilization of the accelerator is summarized, together with research progress on nucleon structure, nuclear physics, meson electro- and photoproduction, chemistry, and gas ionization. Research on electron storage ring beams, development of storage rings and assorted experimental equipment, and radiation control and technological activities are also reported. (D.C.W.)

**22553** (NASA-TN-D-2279) TRANSPORT EQUATIONS FOR A PARTIALLY IONIZED GAS IN AN ELECTRIC FIELD. Peter M. Sockol (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Apr. 1964. 19p.

Transport equations for a partially ionized gas in an electric field are derived from the Boltzmann equation by the Grad 13-moment method. Charged particle interactions are described by Coulomb forces, while all other particle interactions are described by a rigid elastic sphere model. First approximations to currents, stresses, and heat fluxes are obtained. The resulting transport relations are suitable for use in situations in which the electrons have an elevated temperature. (auth)

**22554** (PA-TR-3090) STUDIES OF T-TUBE AND PARALLEL PLATE EXPLODING WIRE ACCELERATORS. Lloyd M. Schack and H. C. Wispell (Picatinny Arsenal. Feltman Research Labs., Dover, N. J.). Sept. 1963. 76p. (AD-419495)

Apparatus and techniques for direct simulation of the effects of ion debris from high-altitude nuclear explosions are being developed. While the coaxial accelerator was being completed, a T-tube accelerator and a parallel-plate accelerator using Al wire as the plasma source were used. A bell jar housing the accelerators simulated altitudes up to 300,000 ft. Theory for the accelerators and for target damage is presented, and the accelerators and diagnostic equipment and techniques are described. The results of some experiments performed are presented. (D.C.W.)

**22555** (AI-Trans-43) CALCULATION OF OPTICAL AND ELECTROSTATIC LATTICE POTENTIALS. P. P. Ewald. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from Ann. Physik, 64: 253-87(1961). 44p.

Optical (electrodynamic) and electrostatic potentials of crystal lattices are first shown as sums of single potentials: $\sum_{p'} \epsilon p'/Rpp'$, where $\epsilon p'$ = charge, $Rpp'$ is the distance of the lattice point p' from the terminal point P (I). By integral construction of the single potential, $R^2pp'$ is introduced in the exponents of an e-function, and a $\vartheta$-function of three variables as integrands is obtained upon carrying out the summation. For the latter the transformation formula is formulated. By using the transformation on the integrands, the Fourier construction of the potential is ob-

tained using the transformed ϑ-function on the entire path of transformation. For convergence of the series, it is advantageous to use one construction of the ϑ-function on one part of the path of integration, and the other on the other part, introducing a splitting point E (or dimensionless η). A general, readily convergent expression of the electrodynamic potentials, suitable for numerical calculation is formulated. A specialization of this expressed is then obtained. The lattice energy as a result of Coulomb forces between ions (Madelung's constant) in rock salt and fluorite is calculated as an example. (auth)

**22556** TRAPPING OF A CHARGED PARTICLE IN A STATIC MAGNETIC FIELD. Don A. Baker (Los Alamos Scientific Lab., N. Mex.). Am. J. Phys., 32: 347-54(May 1964). (LADC-5962)

The Newton-Lorentz equation of motion $m\,dv/dt = qv \times B$ does not exclude orbit solutions that represent the trapping of a charged particle, which is externally injected into a region of time-independent magnetic field. Specific examples of such orbits are demonstrated. Theorems of Liouville and Poincaré are used to clarify the nature of the restrictions that classical mechanics impose upon the injection and trapping of charged particles in a static magnetic field. (auth)

**22557** TRANSITION FROM MULTIPLE-AVALANCHE TO SINGLE-AVALANCHE MECHANISM IN THE BREAKDOWN OF AIR IN A HOMOGENEOUS FIELD. H. Ryzko (Uppsala Univ.). Arkiv Fysik, 25: 481-98(1964).

An experimental technique for the measurement of formative time lags in non-irradiated gaps is developed and is used to study the transition from the multiple- to single-avalanche mechanism in humid air. At pw = 15 mm Hg and pd = 600 cm × m Hg the change of mechanism in breakdown took place at overvoltages of 4 to 6%. This value was found to be much lower than that for dry air (8%). (L.B.S.)

**22558** WAVE PROPERTIES OF A COHERENT AND TURBID FLUID. Francis Fer. Compt. Rend., 258: 3435-8(Apr. 1, 1964). (In French)

A correspondence between the previously developed magnetohydrodynamic equations and the Schroedinger wave equation is established and discussed. (D.C.W.)

**22559** MULTIPLE-BEAM CROSSED-FIELD INTERACTION. R. P. Wadhwa (Univ. of Michigan, Ann Arbor). J. Electron. Control (1), 16: 121-39(Feb. 1964).

The dispersion relations for the crossed-field double-beam drift space amplifier are developed in terms of the two beam currents and the plasma frequencies, and the correspondence between the two equations is discussed. In general, there are two growing waves and two declining waves. Through control of the various operating parameters all these waves can be made unchanging. The propagation constants of the cyclotron and space-charge waves depend very much upon the values of the velocity slip parameter, $\omega_c/\omega$ and $\omega_p/\omega_c$. In the presence of a slow-wave circuit the fast growing wave is excited only for large values of the velocity slip parameter. The gain is found to be larger for the double-beam device than for a single-beam device. The growth rate is proportional to the interaction parameter and depends very much upon the bunching of the beam. A wide velocity distribution in the beam reduces the gain of the slow wave. The importance of the a-c transverse field is also discussed. (auth)

**22560** DOPPLER AND CERENKOV EFFECT IN AN ANISOTROPIC FERRITE. Musa Yildiz (Raytheon Co., Wayland, Mass.). J. Electron. Control (1), 16: 141-52 (Feb. 1964).

The Doppler effect is treated for motion of an oscillator along the axis of an anisotropic ferrite. Explicit expressions for the field components are obtained. These can be used, in particular, to obtain formulas for the Cherenkov radiation of a charge and of a dipole. A number of properties of the radiation that are peculiar to an anisotropic medium are pointed out. Some new effects, occurring in changes of the components of the electromagnetic field and in additional splitting of the original frequency, depend on degree of anisotropy and on the values of the tensor parameters of the ferrite. (auth)

**22561** $Co^{57}$–$Fe^{57}$ SOURCES FOR MÖSSBAUER EFFECT MEASUREMENT. István Dézsi. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 111-18(1964). (In Hungarian)

The preparation of $^{57}Co$–$^{57}Fe$ sources for measurement of the Mössbauer effect is described. Carrier-free $^{57}Co$ was embedded in stainless steel, chrome, and palladium metal. $^{57}Co$ was first deposited on foil surfaces using electroplating or "freeze drying" technique. The specimens were then annealed at 850°C. The characteristics of the sources prepared in this way comply with the requirements of the planned experiments. (auth)

**22562** TRAPPING AND COMPRESSING ELECTRIC FIELDS. K. A. George (Tata Inst. of Fundamental Research, Bombay). Nature, 202: 380-1(Apr. 25, 1964).

The diffusion of transient electric fields into a conducting medium and the subsequent trapping and compressing of the fields are discussed. A long conducting cylinder is considered. (C.E.S.)

**22563** A RAPID DIFFRACTOMETER METHOD TO DETERMINE BACKGROUND INTENSITIES FOR PREFERRED ORIENTATION MEASUREMENTS. John P. Le Geros (New York Univ., New York). Norelco Reptr., 10: 105-7(July-Sept. 1963).

A method was developed to predict the background intensity for each diffraction peak when only a few background measurements have been made on a sample. The formula is given for calculating the background intensity. Once the constants have been determined for particular diffraction angle ranges, they can be used as constants in the formula to predict background for all preferred orientation measurements on any sample of a given material mounted in a given medium (as long as the alignment of the diffractometer is not disturbed and diffraction measurements are conducted with approximately the x-ray source intensity as when the factors were initially determined). (P.C.H.)

**22564** REMARKS ON KUBO'S FORMULA AND ON KADANOFF-BAYM'S EQUATIONS. S. Fujita (Université Libre, Brussels). Phys. Letters, 9: 119-20(Apr. 1, 1964).

Kubo's formula is expressed in a form that refers to the average current rather than to the more complicated current correlation function. Partial Green functions are introduced to evaluate the time integral of the average current, and exact evolution equations for these functions are found by means of a diagram technique. (L.B.S.)

**22565** ON THE CONVOLUTION APPROXIMATION AND THE RAYLEIGH SCATTERING OF LIGHT BY A LIQUID. K. S. Singwi (Argonne National Lab., Ill.) and A. Sjolander. Phys. Letters, 9: 120-1(Apr. 1, 1964).

It is shown that use of the convolution theory for evaluating the differential scattering cross section formula does not lead to Brillouin–Mandelstam components, but to an undisplaced Rayleigh line with a width determined by the macroscopic self-diffusion constant. (L.B.S.)

**22566** ON THE CORRELATION-FUNCTION THEORY OF TRANSPORT IN NON-UNIFORM SYSTEMS. H. Mori (Kyoto Univ.). Phys. Letters, 9: 136-7(Apr. 1, 1964).

The projection operator method is used in an investigation of the formulation of transport coefficients in terms of time correlations of dynamical fluxes in the equilibrium state. The equation for the change in time of the average value of the set A of collective variables comprising the particle density, the hamiltonian density and the momentum density, and a linear relation between the thermodynamic fluxes and the thermodynamics forces are derived. (L.B.S.)

**22567** ON THE ASYMPTOTIC FORM OF THE TRANSPORT EQUATION IN DENSE HOMOGENEOUS GASES. P. Resibois (Université Libre, Brussels). Phys. Letters, 9: 139-41(Apr. 1, 1964).

Stecki's proof of the equivalence between Bogoliubov's theory and Pregogine's formalism for the long time limit of the transport equation of a moderately dense gas is substantiated. (L.B.S.)

**22568** MAGNETIC PROPERTIES OF NEARLY FREE ELECTRONS. NONOSCILLATORY MAGNETIC SUSCEPTIBILITY. M. L. Glasser (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev., 134: A1296-9(June 1, 1964).

The partition function is derived for a gas of electrons in the presence of a weak periodic potential and uniform magnetic field. From it the steady terms in the free energy and the zero-field–zero-temperature total electronic magnetic susceptibility are calculated. The results are applied to the alkali metals. The non-additivity of the paramagnetic and diamagnetic susceptibilities and the inadequacy of the effective mass approximation are discussed. (auth)

**22569** REDETERMINATION OF THE TEMPERATURE DEPENDENCE OF X RAYS ANOMALOUSLY TRANSMITTED THROUGH GERMANIUM. Boris W. Batterman (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 134: A1354-6(June 1, 1964).

The temperature dependence of the anomalously transmitted x rays through single crystals of germanium of effective thicknesses, $\mu_0 t = 20$ and 30 was redetermined. It was established, as suggested by Okkerse, that the earlier measurements were subject to error due to a thermal gradient perpendicular to the diffracting planes. By suitable rearrangement of the heating geometry this type of gradient was substantially removed. The current results are in agreement with those of Okkerse and indicate that the data can be explained by allowing the imaginary part of the scattering factor to depend on temperature as exp (–M) where M is based on a Debye temperature of 291°K. It is felt that there is insufficient evidence at present to conclude in general that the temperature dependence in dynamical diffraction is exp (–M). (auth)

**22570** DISTRIBUTION FUNCTIONS FOR THE NUMBER OF DISTINCT SITES VISITED IN A RANDOM WALK ON CUBIC LATTICES: RELATION TO DETECT ANNEALING. J. R. Beeler, Jr. (General Electric Co., Cincinnati). Phys. Rev., 134: A1396-1401(June 1, 1964).

Distribution functions for the number of distinct sites S(n) visited by a point defect executing a symmetric random walk of n jumps on two- and three-dimensional lattices were computed using the Monte Carlo method. The square planar, simple cubic, b-c-c, and f-c-c lattices were treated. In three dimensions, the normal distribution appears to describe S(n) for $n > 10^4$ jumps and at $10^4$ jumps the derivative $d\bar{S}(n)/dn$ of the average number, $\bar{S}(n)$, of distinct sites is within 0.5% of the value given by Vineyard's exact asymptotic solution. The defect annealing rate was computed using the S(n) distribution in a simple example and this result compared with an analog Monte Carlo solution. The comparison indicated that fluctuations in the initial defect concentration must be considered in computing the initial annealing rate and the mobile defect concentration as a function of time. After 500 jumps the annealing rate, but not the concentration, can be closely approximated without accounting for fluctuations in the initial concentration. (auth)

**22571** DOPPLER-SHIFTED CYCLOTRON RESONANCE WITH HELICON WAVES IN SODIUM. M. T. Taylor (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 12: 497-9(May 4, 1964).

A method of studying the Kjeldaas edge–the maximum magnetic field at which Doppler-shifted cyclotron resonance is possible–is described for simple metals. Cyclotron resonance analysis was performed on sodium using helicon waves with frequencies about $10^{-4}$ as large as the electron cyclotron frequency. The experimental technique promises to produce accurate curvature measurements at Fermi-surface points. (M.J.T.)

**22572** MAGNETIZATION PROCESS OF A SCREW SPIN SYSTEM. [PART] II. Yoshiharu Kitano (Univ. of Osaka Prefecture) and Takeo Nagamiya. Progr. Theoret. Phys. (Kyoto), 31: 1-43(Jan. 1964).

Magnetization processes and structure changes in helical and modified helical spin arrangements due to application of a magnetic field are studied for finite temperatures and absolute zero in cases of different anisotropy energy. For strong anisotropy producing a proper helical structure and for no anisotropy within the plane, a field applied within the plane causes structure changes from helix to fan and then to parallel alignment as the field is increased. It is shown that the first transition is of the second kind when the temperature is close to the Néel temperature; whereas it is of the first kind below a certain critical temperature. The second transition is always of the second kind. The case of p-fold symmetry within the plane is also studied. In particular, the case of twofold symmetry with a field applied either along the easy or hard direction is studied for arbitrary temperatures. The case of sixfold symmetry is studied for absolute zero. It is shown that, with an applied field along one of the easy directions, the transition from fan to ferromagnetism becomes discontinuous (i.e., of the first kind) when the anisotropy constant increases, and that the fan structure disappears with a further increase in the anisotropy constant. With a field applied along one of the six hard directions, the fan structure does not disappear, and there appears an oblique ferromagnetism at higher values of the anisotropy constant. Structure changes for longitudinal sinusoidal, oblique helix, and conical structure are discussed. Comparison with experiment is made on a number of materials, particularly on Ho, and most observed features are accounted for. (auth)

**22573** A METHOD FOR EVALUATING A CLASS OF PARTITION FUNCTIONS. [PART] I. Giiti Iwata (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 67-82(Jan. 1964).

An approximate method for evaluating a class of partition functions as appearing in classical statistical mechanics is described. A partition function is expressed as an integral of the product of a Boltzmann factor involving the energy quadratic and a weighting factor over the whole space of integration. The whole space of integration is divided into cells by a set of families of quadratic and linear surfaces so selected that the Boltzmann factor

varies as little as possible in each of the cells. The weighting factor is averaged over each of the cells. The method is applied to the evaluation of the grand partition function of a one-component system, consisting of particles interacting through a pairwise potential, to provide an equation of state, points of phase transition, and the rule of equal areas. As an example, the equation of state of a system interacting through a repulsive Yukawa potential is shown. The result of the present method is compared with that of the virial expansion. (auth)

**22574** PRODUCTION OF VERY HIGH MAGNETIC FIELDS BY FLUX COMPRESSION. J. D. Lewin and P. F. Smith (Rutherford Lab., Chilton, Berks, Eng.). Rev. Sci. Instr., 35: 541-8(May 1964).

Some theoretical aspects of the implosion technique of attaining magnetic fields in the megagauss region are discussed. The temperature rise at the conductor surface is estimated, taking into account the change in resistivity with temperature. At all field levels the magnetic pressure should prevent loss of conductor by evaporation. Flux leakage due to finite conductivity is analyzed, allowing for the variation of resistivity and penetration depth during compression; to account for reported fields as high as 14 MG, the temperature coefficient of resistivity under implosion conditions must be at least two orders of magnitude lower than at normal pressures. (auth)

**22575** SLIDE RULE METHOD FOR INDEXING ELECTRON DIFFRACTION PATTERNS. W. R. Roser and G. Thomas (Univ. of California, Berkeley). Rev. Sci. Instr., 35: 613-15(May 1964).

A convenient and rapid slide rule method for use in transmission electron microscopy is described. (R.E.U.)

**22576** ELECTRICAL LEAD SEALS FOR CRYOGENIC APPLICATIONS. W. R. Roach (Univ. of Illinois, Urbana), J. C. Wheatley, A. C. Mota de Victoria. Rev. Sci. Instr., 35: 634-6(May 1964). (TID-20098)

A method for sealing electrical leads into a vacuum space surrounded by liquid helium below the lambda-point is described. The seals were devised for adiabatic demagnetization studies and can withstand shock immersion in liquid nitrogen or helium without leakage. The seals use the epoxy resin Epibond 100-A, which is a diglycidal ether of bisphenol having the hardener dispersed within. (R.E.U.)

**22577** STUDIES ON X-AGENT. XXXIII. FURTHER STUDIES ON TIME-FLUCTUATION OF X-AGENT. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 14: 269-86(Dec. 1963).

Annual fluctuation of X-agent was revealed in the continued observation on transmittance change of the frosted surface of a small glass vessel (absorption cell for the Leitz-photometer) which was placed close by a water bottle. The change of the transmittance was most striking in early summer, whereas in late winter or in early spring it was very obscure. The change was rather indistinct also in autumn, but in late autumn or in early winter it tended to become marked. Color change of methyl-red solution shows a similar annual variation, although the feature of the variation is somewhat different from that observed with the frosted glass surface. In addition to such annual variation, diurnal variation can be demonstrated in X-agent in its influence on the cloudiness produced on the addition of bismuth chloride to water. Similar diurnal fluctuation has previously been observed with the change in the frosted glass surface. By studying the manner of the formation of bismuth-oxychloride precipitation, it becomes clear that the X-agent is also fluctuating incessantly with the progress of time with periods of several minutes. (17 references.) (auth)

**22578** POWER SYSTEMS FOR SPACE FLIGHT. Morris A. Zipkin and Russell N. Edwards, eds. Progress in Astronautics and Aeronautics Series. Volume 11. New York, Academic Press, 1963. 956p. $13.50.

Separate abstracts were prepared for 6 of the 44 papers presented at the ARS Space Power Systems Conference held in Santa Monica in September 1962. Thirteen papers were previously included in NSA (17: 6731, 7649, 7680, 8337, 9112, 9117, 9119, 9124, 9130, 9134, 10213, 11315, and 33393). Those papers not included are on selection of power systems, chemical power systems, solar power systems, heat rejection from surfaces, and heat radiator design for space. (R.E.U.)

*For abstracts of individual papers see: 22579, 22580, 22581, 22716, 23094, and 23095.*

**22579** POWER SUPPLIES FOR MOBILE LUNAR VEHICLES. Raymond G. Roble, Hwei-Kai Hse, and George T. Burton (Bendix Corp., Southfield, Mich.). p.81-103 of "Power Systems for Space Flight." New York, Academic Press, 1963.

The criteria used in the selection of power supplies for mobile lunar vehicles differ somewhat from those employed in the selection of power supplies for orbiting space vehicles. This results principally from the different environment in which the two operate. A parametric analysis was conducted on the power supplies capable of providing power to two types of vehicles; an unmanned vehicle for a 100-earth-day mission, and a manned vehicle for a 7-earth-day mission. Account was taken of the hostile lunar environment and its effect on the system parameters. On the basis of the established parameters and design considerations, a selection of a suitable power supply for the particular missions was made. (auth)

**22580** LITHIUM HYDRIDE STORAGE UNIT DEVELOPMENT FOR THE SUNFLOWER SYSTEM. R. A. McKinnon (Thompson Ramo Wooldridge Inc., Cleveland). p.447-60 of "Power Systems for Space Flight." New York, Academic Press, 1963.

Lithium hydride is employed as the heat storage medium in the Sunflower system to provide continuous power conversion during the shade time of earth orbits. Two small scale investigations were conducted in the development of the heat storage unit prior to design and fabrication of full scale hardware. Several characteristics of lithium hydride are discussed and their influence on the design philosophy indicated. The results of the small scale investigations and the design and test results of the full scale ground development units are presented. (auth)

**22581** SPACE DEMONSTRATION OF A RANKINE CYCLE SPACE POWER SYSTEM. George E. Thompson (Air Force, Wright-Patterson AFB, Ohio), Floyd E. Creasey, and Robert L. Cummings. p.869-90 of "Power Systems for Space Flight." New York, Academic Press, 1963.

The launch of a Rankine power system was intended to show the operating capability of the experimental space power system during the severe environment of the launching period and to place the power system in a ballistic trajectory to obtain a 25-min. period of operation in zero gravity. Although no zero-gravity data were obtained, the test has furnished interesting results that can, at least, provide good general guidance on problems involved in future space power systems. (auth)

**22582** STATISTICAL PHYSICS. G. E. Uhlenbeck, N. Rosenzweig, A. J. F. Siegert, E. T. Jaynes, and S. Fujita. Brandeis University Summer Institute Lectures in Theoretical Physics. Volume 3. New York, W. A. Benjamin, Inc., 1963. 257p.

Separate abstracts were prepared for two of the five lectures presented; the remaining topics are on statistical mechanics. Numerous references. (R.E.U.)

**22583** APPROACH TO EQUILIBRIUM OF A MANY-PARTICLE SYSTEM. S. Fujita (Universite Libre, Brussels). p.219-52 of "Statistical Physics." New York, W. A. Benjamin, Inc., 1963.

The density operator and hamiltonian for many-body systems, the Pauli equation (master equation), initial conditions, and generalized equations describing the approach to equilibrium of systems of many particles are discussed. A review is presented of progress in understanding of the statistical mechanics of irreversible processes. (R.E.U.)

**22584** MAGNETIC RESONANCE AT HIGH PRESSURE. G. B. Benedek. Interscience Tracts on Physics and Astronomy. New York, Interscience Publishers, 1963. 108p.

Magnetic resonance theory and experiments for solids, liquids, and gases under high pressure are discussed. Methods and materials for magnetic resonance experiments for pressures of 1 to 65 kilobars and 1 to 400°K are described. Numerous references. (R.E.U.)

**22585** CRYOGENIC ENGINEERING. J. H. Bell, Jr. Prentice-Hall International Series in Space Technology. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1963. 422p. $11.95.

The thermodynamics of cryogenic systems, air—the cryogenic fluid, separation of gases, insulation, materials of construction, vessel construction, transport and transfer of cryogenic liquids, instrumentation, special cryogenic problems, cryogenics in industry, and the future of cryogenics are considered. Numerous graphs, references, and tables. (R.E.U.)

## Accelerators

**22586** (CERN-64-19) THE CERN ELECTRON STORAGE RING MODEL. PART I. DESIGN AND CONSTRUCTION. F. A. Ferger, E. Fischer, E. Jones, P. T. Kirstein, H. Koziol, and M. J. Pentz. PART II. RUNNING-IN AND PRELIMINARY PERFORMANCE. F. A. Ferger, E. Fischer, S. Hansen, E. Jones, H. Koziol, J. Leroux, and M. J. Pentz (European Organization for Nuclear Research, Geneva). Apr. 14, 1964. 49p.

The storage ring has a circumference of 24 m and is designed for electrons of up to 100 Mev or protons of up to 5 Mev. Initial operation was with 2-Mev electrons. A beam of several milliamperes was injected, and preliminary measurements were made on the beam. The storage ring is described (orbit and magnet parameters are included), and the initial operation and measurements are summarized. (D.C.W.)

**22587** (JINR-P-1590) RASCHET MAGNITIYKH FOKUSIRUYUSHCHIKH SISTEM DLYA PUCHKOV CHASTITS VYSOKOI ENERGI. (Calculation of Magnetic Focusing Systems for Beams of High-Energy Particles). V. V. Miller (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 42p.

The properties of lenses and focusing magnets are described, as well as the methods of calculating the simplest systems. The principles of constructing complicated magnetic systems, the compensation of dispersion and aberrations, etc. are emphasized. Methods of beam production are also reviewed. (auth)

**22588** (NP-13896(p.23-8)) ONE-DIMENSIONAL ELECTRON BEAM MODEL: COMPUTER EXPERIMENTS. Gary H. Herling and Laura C. Davis (Naval Research Lab., Washington, D. C.).

Some calculations performed for small systems using the one-dimensional model are reviewed, and possible improvements in the calculations are discussed. (D.C.W.)

**22589** (NP-13896(p.29-33)) GRAPHITE FILTERING OF BREMSSTRAHLUNG X RAYS. M. Elaine Toms (Naval Research Lab., Washington, D. C.).

The possibility of using various lengths of graphite to filter bremsstrahlung produced by incidence of electrons from the NRL linear accelerator on aluminum was investigated. The spectra produced by filtering 16.5-, 21.5-, and 26.5-Mev bremsstrahlung x-rays by graphite (150, 200, 250, and 300 g/cm$^2$) were calculated. Even the least filtering greatly improved the proportion of useful photons, but the number of photons emerging from the filters decreased rapidly with increasing thickness. The peaks of the spectra tend to shift to higher energies and to flatten out with increasing thickness. (D.C.W.)

**22590** (NP-13896(p.51-2)) FILAMENTARY PHASE SPACE CONFIGURATIONS FOR A SHEET BEAM. D. C. dePackh (Naval Research Lab., Washington, D. C.).

Phase space configurations in which the population is rather narrowly confined to the region of a line or filament, the position of which may be time-varying, arise in the injection of particles into a betatron. The equations of motion of such a filament are given, and its equilibrium configuration is determined. The equation for small perturbations of the equilibrium is also included. (D.C.W.)

**22591** (NP-13896(p.53-66)) A SOLENOID-FOCUSED GUIDE RING FOR THE STORAGE OF AN INTENSE ELECTRON BEAM (THE SOZOTRON). Report No. 3. D. dePackh, R. Close, L. Davis, et al. (Naval Research Lab., Washington, D. C.).

Theoretical, experimental, engineering, and technological progress on the Sozotron is reported. (D.C.W.)

**22592** (PAN-477/IA) STABILIZACJA POLA MAGNETYCZNEGO ELEKTROMAGNESU ODCHYLAJACEGO WIAZKE PROTONOW O ENERGII 500 kev. (Stabilization of Magnetic Field in Electromagnet Deflecting 500-kev Proton Beam). Anna Mekper (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 19p.

The design construction and performance of a magnetic field stabilizer with a tolerance of $3 \cdot 10^{-5}$ for the electromagnet supplied by line voltage, is described. It includes the two loops of regulation: current stabilizer with accuracy of (2 to 3) $\times 10^{-5}$ for an hour and $2 \times 10^{-4}$ for an indefinite time and automatic correction of magnetic field intensity, which takes advantage of the phenomenon of nuclear magnetic resonance absorption and provides stability of magnetic field to $3 \times 10^{-6}$. The sample of NMR has a capacity of 0.03 cm$^3$ and is filled with a 0.25 molar solution of $Fe(NO_3)_3$. (auth)

**22593** (SLAC-27) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, October 1–December 31, 1963. (Stanford Univ., Calif. Stanford Linear Accelerator Center). Feb. 1964. Contracts AT(04-3)-400 and AT(04-3)-476. 93p.

Development of accelerator structures, klystrons, the physical slant, magnets, vacuum system, electronic and microwave equipment, and beam control and handling equipment is reported. Operation and modification of the Mark IV accelerator are also summarized, together with experimental and theoretical studies of particle production and interactions. (D.C.W.)

**22594** (TID-7691) MINUTES OF THE CONFERENCE ON PROTON LINEAR ACCELERATORS AT YALE UNIVERSITY, OCTOBER 21–25, 1963. H. B. Knowles, ed. (Yale Univ., New Haven). Feb. 1964. Contract AT(30-1)-1349. 490p.

Separate abstracts were prepared for 38 of the 39 papers presented; one was previously abstracted for NSA. See abstract 18: 8951. (R.E.U.)

*For abstracts of individual papers see: 22595, 22596, 22597, 22598, 22599, 22600, 22601, 22602, 22603, 22604, 22605, 22606, 22607, 22608, 22609, 22610, 22611, 22612, 22613, 22614, 22615, 22616, 22617, 22618, 22619, 22620, 22621, 22622, 22623, 22624, 22625, 22626, 22627, 22628, 22629, 22630, 22631, and 22632.*

**22595** (TID-7691(p.1-13) COUPLED PHASE AND RADIAL MOTION IN LINEAR ACCELERATORS. D. A. Swenson (Midwestern Universities Research Assn., Madison).

The phase and radial dynamics program at MURA is discussed, and a computer program (PARMILA) used to trace the phase motion and the transverse motions of particles through a proton linear accelerator is described. PARMILA is derived from "Phase and Radial Motion in Linear Accelerators." (R.E.U.)

**22596** (TID-7691(p.14-28)) COMPUTER PROGRAMS FOR PARTICLE MOTION IN LINACS. S. Ohnuma (Yale Univ., New Haven).

Two computer programs for simulating particle motion in linear accelerators are described. One is for the drift tube sections (low-energy region, up to 200 Mev) and the other is for the iris sections (high-energy region). The drift sections include quadrupole magnets inside, and the iris sections have magnets outside of the tanks. (R.E.U.)

**22597** (TID-7691(p.29-48)) THE EFFECTS OF PHASE AND FIELD ERRORS ON THE LONGITUDINAL MOTION IN A LONG PROTON LINAC. G. W. Wheeler and T. W. Ludlam (Yale Univ., New Haven).

The loss of particles from the beam of a long proton linac is considered. The behavior of the beam in longitudinal phase space when subject to errors in average field amplitude and intercavity phase adjustment is considered in order to estimate the degree of precision in phase and field amplitude control required of the r-f system and to help in determining the choice of frequency for the high-energy portion of the accelerator. (R.E.U.)

**22598** (TID-7691(p.49-62)) DEBUNCHING OF HIGH-ENERGY BEAMS. L. C. Teng (Argonne National Lab., Ill.).

The debunching (stretching) caused by the r-f structure of the beam in pulsing linacs is considered. A 938-Mev linac is assumed and representative calculations are presented. (R.E.U.)

**22599** (TID-7691(p.71-3)) DEBUNCHERS FOR SEMI-RELATIVISTIC LINACS. F. E. Mills (Midwestern Universities Research Assn., Madison).

It is shown that a simple magnet system will function as a debuncher for proton linacs above 200 Mev, thereby eliminating the long flight path normally required. The ratio of the time difference to the momentum deviation is investigated. (R.E.U.)

**22600** (TID-7691(p.74-94)) BEAM LOADING AND BEAM BLOWUP IN ELECTRON LINACS. J. E. Leiss (National Bureau of Standards, Washington, D. C.).

Beam loading effects in linacs are discussed in terms of filter theory. Solutions are found for the r-f transmission in the waveguide with beam-loading waves. (R.E.U.)

**22601** (TID-7691(p.95-103)) BEAM LOADING EFFECTS IN PROTON LINACS. R. L. Gluckstern (Yale Univ., New Haven).

The bunched beam of charged particles passing through a cavity interacts with the fields in the cavity. It couples, in addition to other resonant modes, exciting fields that may react on the beam. Two effects are discussed; the interaction with the externally applied accelerating field and subsequent reaction on the beam, and the generation of transverse modes capable of deflecting the beam. (R.E.U.)

**22602** (TID-7691(p.104-30)) CROSSBAR AND CLOVERLEAF STRUCTURES AT RUTHERFORD. A. Carne (Gt. Brit. National Inst. for Research In Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England).

The work at Rutherford Laboratory on a linear injector for a 300-Bev machine at CERN and a possible pion factory is reviewed. The disk-loaded Crossbar, and Cloverleaf waveguide structures are discussed. (R.E.U.)

**22603** (TID-7691(p.131-52)) ACCELERATING STRUCTURE RESEARCH AT LOS ALAMOS. E. A. Knapp (Los Alamos Scientific Lab., N. Mex.).

Measurements made on r-f structures for application in a linac meson factory are reported. The shunt impedance of four waveguide structures suitable for use in an accelerator; two for use in the Alvarez part of the machine, and two for use in the iris-loaded part of the machine, was measured. Substantial agreement was found with results of other linac builders for the shunt impedance in the Alvarez part, but unresolved disagreement was found for the Rutherford Laboratory results for the iris-loaded section. (R.E.U.)

**22604** (TID-7691(p.153-70)) MEASUREMENTS ON IRIS-LOADED WAVEGUIDES. S. Giordano (Yale Univ., New Haven).

Measurements of shunt impedance per unit length, bandwidth, and tank flatness are reported for iris-loaded waveguide structures operating as π-mode standing-wave accelerators. Waveguides with flat, shaped, and slotted irises are considered. (R.E.U.)

**22605** (TID-7691(p.171-89)) STEADY-STATE BEHAVIOR OF A RING OR OF A CHAIN OF COUPLED CIRCUITS. D. E. Nagle and E. A. Knapp (Los Alamos Scientific Lab., N. Mex.).

The characteristics of a linear-accelerator cavity are discussed using an equivalent lumped circuit. The effects of coupling and of perturbations in each cavity are investigated, and numerical results are obtained. (R.E.U.)

**22606** (TID-7691(p.190-5)) EFFECT OF ERRORS IN REPETITIVE STRUCTURES. R. L. Gluckstern (Yale Univ., New Haven).

The practical limit on the length of repetitive electromagnetic structures is determined by the sensitivity of the field distribution to local dimensional errors. An L-C circuit model was used to investigate this effect in iris-loaded cavities where the cells are loosely coupled. (R.E.U.)

**22607** (TID-7691(p.196-203)) STANDING VERSUS TRAVELLING WAVEGUIDES. M. Jakobson (Los Alamos Scientific Lab., N. Mex.).

The use of a proton linac as a traveling-wave accelerator rather than a standing-wave machine is discussed. The changes necessary in the conversion are discussed. (R.E.U.)

**22608** (TID-7691(p.204-20)) DRIFT TUBE STRUCTURES. D. E. Young (Midwestern Universities Research Assn., Stoughton, Wis.).

Linac design data obtained from several computer outputs are considered. Different cavity geometries appropriate for particle acceleration in a 200-Mc standing-wave linac up to 400 Mev are investigated. A variety of parameters describing cylindrical drift tubes with the ends rounded to different radii and with holes, as well as a few ellipsoidal and other shapes of drift tubes are considered. A sample of the output data are presented. (R.E.U.)

**22609** (TID-7691(p.221-30)) THE YALE DRIFT TUBE LINAC. J. N. Vitale (Yale Univ., New Haven).

The Yale linac drift tube is described, and data for each of the six tanks (cavities) is presented. (R.E.U.)

**22610** (TID-7691(p.231-9)) ZGS INJECTOR LINAC. P. Livdahl (Argonne National Lab., Ill.).

Operating experiences for the linac injector for ZGS during continuous run are reported. The beam transport elements and beam emittance at various places were studied. (R.E.U.)

**22611** (TID-7691(p.240-7)) BEVATRON INJECTOR LINAC II. E. L. Hubbard (California. Univ., Berkeley. Lawrence Radiation Lab.).

The drift-tube magnets, r-f system, Cockcroft-Walton preinjector beam, linac acceptance, linac output beam, and injector reliability for the Bevatron Injector Linac II are discussed. (R.E.U.)

**22612** (TID-7691(p.248-66)) AGS INJECTOR AND PREINJECTOR BEAM STUDIES. A. van Steenbergen (Brookhaven National Lab., Upton, N. Y.).

A high-energy longitudinal phase acceptance tail attached to the usual and expected symmetric "fish" diagram was investigated experimentally using a "phase probe" provided by the buncher. The elimination of the effective phase space dilution in the AGS preinjector was attempted to increase the AGS beam intensity. (R.E.U.)

**22613** (TID-7691(p.267-72)) PREBUNCHING IN ELECTRON LINACS. J. E. Leiss (National Bureau of Standards, Washington, D. C.).

The possible use of harmonic bunching in injection cavities in an electron linac is discussed. Large-signal and relativistic effects are considered for 150- to 200-kev electrons. A Fourier series expansion was performed on a fundamental sawtooth shape to obtain phase and amplitude of the harmonics. (R.E.U.)

**22614** (TID-7691(p.273-8)) BUNCHING FOR HIGH-INTENSITY LINACS. S. Ohnuma (Yale Univ., New Haven).

A sawtooth buncher operated at the linac frequency is suggested to obtain a very tight bunch with no long tails on the fish diagrams for 751-kev injected protons. (R.E.U.)

**22615** (TID-7691(p.279-87)) HARMONIC BUNCHING. R. Perry (Argonne National Lab., Ill.).

Calculations made on the use of a multiple-harmonic buncher at ANL are summarized. Sinusoidal, second-, third-, and fourth-harmonic bunchings are considered, and phase-energy distributions are shown. (R.E.U.)

**22616** (TID-7691(p.288-300)) INJECTION INTO FFAG ACCELERATORS. C. D. Curtis (Midwestern Universities Research Assn., Stoughton, Wis.).

The perturbed equilibrium orbit, or field bump, scheme of circular injection beam filling of accelerator acceptance by means of multiturn injection is discussed. (R.E.U.)

**22617** (TID-7691(p.301-10)) INJECTION INTO THE BNL AGS. E. D. Courant (Brookhaven National Lab., Upton, N. Y. and Yale Univ., New Haven.)

The overall phase space and energy spread requirements of a linear accelerator used as a 1-Bev injector for AGS are discussed. (R.E.U.)

**22618** (TID-7691(p.311-20)) RF POWER SOURCES. D. C. Hagerman (Los Alamos Scientific Lab., N. Mex.).

Radio-frequency power sources for linear accelerators for meson factories operating at 800 Mev are discussed. Gridded tubes and klystrons are compared for control sensitivity, cost, and efficiency. (R.E.U.)

**22619** (TID-7691(p.321-32)) MULTIPLE EXCITATION OF RF CAVITIES WITH AN RF MANIFOLD. F. Voelker (California. Univ., Berkeley. Lawrence Radiation Lab.).

An r-f manifold, i.e., a way of tying several r-f power amplifiers to a large number of cavities, is suggested for economic reasons and to allow the linac tanks to be shortened for better mode control. (R.E.U.)

**22620** (TID-7691(p.333-60)) RADIATION HAZARDS OF A HIGH-INTENSITY PROTON LINEAR ACCELERATOR. H. B. Knowles (Yale Univ., New Haven).

Radiation hazards produced by 1-Bev protons from a linac are discussed; shielding, radiation damage, and activation are considered. Common materials associated with accelerator facilities are discussed with regard to the hazards produced by the primary proton beam and the many possible secondary beams. Radiation hazards are summarized for separate sections of the 800-Mev Yale proton linac. 30 references. (R.E.U.)

**22621** (TID-7691(p.361-81)) BEAM HANDLING. R. D. Edge (Yale Univ., New Haven).

The beam parameters for the Yale proton linac are defined. The various ways of diverting the primary proton and secondary beams and some experiments using these beams are discussed. (R.E.U.)

**22622** (TID-7691(p.382-95)) A MESON FACTORY EXPERIMENTAL TARGET AREA DESIGN. A. D. McGuire (Los Alamos Scientific Lab., N. Mex.).

A meson factory experimental area utilizing a 1-mamp. beam of 800-Mev protons from a linac is described. Various experiments possible with the experimental setup are discussed. (R.E.U.)

**22623** (TID-7691(p.396-403)) REVIEW OF PARAMETERS FOR AN 100-Mev INJECTOR FOR THE 70-Gev USSR SYNCHROTRON. I. J. Polk (Brookhaven National Lab., Upton, N. Y.).

Parameters for the 100-Mev linac injector used with the 70-Bev USSR synchrotron in Serpuchov, as taken from ITEP report NTD634A, are given. (R.E.U.)

**22624** (TID-7691(p.404-20)) THE RUTHERFORD P.L.A. AND A LINAC FOR THE HIGH-ENERGY ACCELERATOR DESIGN STUDY. J. M. Dickson, K. Batchelor, D. J. Warner, and A. Carne (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England).

The 200-Mev linac for the 300-Bev proton-synchrotron at CERN is described. Parameters for the Rutherford Proton Linear Accelerator tanks are given, as designed for the CERN injector. (R.E.U.)

**22625** (TID-7691(p.421-30)) VACUUM REQUIREMENTS FOR LINACS. P. Grand (Yale Univ., New Haven).

The vacuum standards maintained for linear accelerators are reviewed with view to improvement of electrical breakdown conditions and beam scattering from residual gases

in the evacuated chamber. The reliability, operation and maintenance, and capital investment of systems capable of $10^{-6}$ torr are considered as major design requirements. Diffusion, ion, and Evapor-ion pumps are discussed. (R.E.U.)

**22626** (TID-7691(p.431-41)) THE HYDROGEN PURGING TECHNIQUE. H. G. Worstell (Los Alamos Scientific Lab., N. Mex.).

The design and operation of the PHERMEX machine at Los Alamos, which uses $H_2$ purging, are discussed. (R.E.U.)

**22627** (TID-7691(p.442-8)) VACUUM TECHNIQUES. P. Livdahl (Argonne National Lab., Ill.).

Vacuum techniques associated with the Zero-Gradient Synchrotron linac at ANL are discussed. The performance of the linac pumping system is discussed. (R.E.U.)

**22628** (TID-7691(p.449-55)) LINAC FABRICATION PROBLEMS. P. Livdahl (Argonne National Lab., Ill.).

A discussion is presented of design and fabrication characteristics of the Argonne Synchrotron injector linac. The mechanical fabrication of the tanks for the ZGS linac and cladding of steel with thick copper are discussed. (R.E.U.)

**22629** (TID-7691(p.456-8)) DIFFUSION TECHNIQUES IN WAVEGUIDE FABRICATION. M. V. Hoover (Radio Corp. of America, Camden, N. J.).

Problems associated with the fabrication of waveguides are discussed. (R.E.U.)

**22630** (TID-7691(p.459-62)) A DEMOUNTABLE WAVEGUIDE ASSEMBLY METHOD. I. J. Polk (Brookhaven National Lab., Upton, N. Y.).

A nonvacuum-tight precision iris-loaded waveguide for an electron linac at Orsay is described. The fabrication features elimination of individual cutting of cavities and joining of the repetitive structures by steel water-coolant tubes. (R.E.U.)

**22631** (TID-7691(p.463-6)) ALIGNMENT TECHNIQUES. O. S. Reading (Brookhaven National Lab., Upton, N. Y.).

Methods used at BNL for aligning the linac during shutdown and some expected and necessary tolerances are given. (R.E.U.)

**22632** (TID-7691(p.467-79)) A MESON FACTORY BUILDING DESIGN. C. W. Dunham (Yale Univ., New Haven).

The planning of structures to house a proton linac and its associated components for a meson factory is discussed. Schematic layout designs are shown. Some siting and construction requirements are discussed. (R.E.U.)

**22633** (UCRL-11184(p.136-40)) CHARACTERISTICS AND INTENSITY PROFILE OF A HIGH-ENERGY-PROTON BEAM AFTER SCATTERING IN A THICK TARGET. Roger Wallace, Kenneth Kase, and Charles A. Sondhaus (California. Univ., Berkeley. Donner Lab.; California. Univ., Berkeley. Donner Pavilion; and California. Univ., Berkley. Lawrence Radiation Lab.).

In order to determine the intensity profile of a proton beam degraded by scattering, calculations were made based on the analysis of a variable energy beam for the proposed National Aeronautics and Space Administration synchrocyclotron. This was extended to the broad beam case for biological use. The initial beam was assumed to be a thin pencil of monoenergetic 730-Mev protons. This initial beam was then assumed to be degraded in a C or Cu scatterer to some final energy. The beam profile at some given distance from the scatterer was calculated using circular Gaussian error probabilities, and the remanent intensity was then determined. It appears from these calculations and those for depth dose that the stepwise simulation of a solar-flare proton exposure in the lethal dose range would be possible by using as few as three proton energies, of say 50, 100, and 400 Mev in the intensity ratio 5:2:1 such as to produce a midline dose in the order of 200 to 400 rad. It appears that this would require very roughly a 10-min exposure to 400-Mev protons, a 20-min exposure to 100-Mev protons and a 2- to 4-hr exposure to 50-Mev protons if the scattering targets discussed here are used. To produce the lowest energy proton dose in the outer 2 cm of tissue appears to be the most time-consuming step. Rotating the animal in the 88-in. cyclotron beam may be a logical procedure for this part of the exposure. For the production of a uniform total-body proton dose in a large animal, however, the scattering technique appears to lead to reasonable exposure times at fairly high energies. (auth)

**22634** FIELDS EXCITED BY PERIODIC BEAM CURRENTS IN A CAVITY-LOADED TUBE. F. J. Kriegler (Midwestern Universities Research Association, Stoughton, Wis.), F. E. Mills, and J. van Bladel. J. Appl. Phys., 35: 1721-6(June 1964).

A method is given for the determination of the electromagnetic fields excited in accelerator cavities by a bunched beam of charged particles passing through the cavities. The electric and magnetic fields within a cavity are determined by solving a coupled regions problem, where the regions consist of a coaxial cavity and a cylindrical waveguide coupled through a gap. Numerical results are obtained by use of a digital computer for a few configurations representing linear accelerator cavities with drift tubes. The results are presented as a series of normalized curves of pertinent electrical quantities; they should give a clear qualitative picture of the effects of beam loading in linear accelerator cavities. Owing to space limitations, only the fundamental resonance excited by the fundamental beam harmonic was investigated in any detail. The general expressions advanced can be used to investigate higher-order resonances excited by higher-order beam harmonics. (auth)

**22635** THE EFFECT OF PREVIOUS BUNCHING OF PARTICLES ON PHASE WIDTH OF CAPTURE IN A LINEAR hf ELECTRON ACCELERATOR. Václav Sochor (Czech. Tech. Univ., Prague). Jaderna Energie, 10: 76-8 (1964). (In Czech.)

The number of electrons captured in an accelerator system is determined by the shape of the curve for potential energy of the motion with respect to the synchronous particle. The capture phase width always is less than $2\pi$. Therefore, a part of injected electrons remains uncaptured during the whole h-f period. The use of a klystron type bunching device enables clusters of particles in the beam to be formed by means of velocity modulation, the phase width of which is equal to the capture phase width. Thereafter the number of captured particles is substantially increased. However, the particle bunching has negative results as well, the capture phase width decreases due to the influence of the space charge and of the scattering of particle velocities in the bunch. The characteristics of the bunching device must be chosen so that this undesirable influence may be negligible. (auth)

**22636** CRYOGENIC SYSTEM FOR THE PRODUCTION OF VERY THIN TARGETS. P. B. Parks, P. M. Beard, E. G. Bilpuch, and H. W. Newson (Duke Univ., Durham, N. C.). Rev. Sci. Instr., 35: 549-57(May 1964). (TID-19666)

A windowless gas target chamber was developed for the

production of very thin, but uniform, targets to be used with accelerated charged particle beams. The target reaction chamber is appended to a cryostat that is capable of containing liquid helium as the primary refrigerant. The temperature of this chamber can be adjusted so that condensation of the gas in the vicinity of the beam path is minimized. The cryostat freezes out the gas that escapes the reaction chamber. To date, the new cryogenic technique was used to observe the $^{2}D(d,n)$ reaction and the (p,n) reaction in $^{11}B$, $^{40}Ar$, and $^{37}Cl$. Very narrow resonances (widths ≤450 ev) were discovered in the $^{40}Ar(p,n)^{40}K$ reaction near the neutron threshold. The narrowest observed widths in the yield curve are 140 ± 10 ev. These were observed with a target whose effective density was found to be $3.0 \pm 0.3 \times 10^{16}$ atoms/cm$^2$. (auth)

**22637** ACHROMATIC TRANSLATION SYSTEM FOR CHARGED PARTICLE BEAMS. D. A. Swenson (Midwestern Universities Research Association, Madison). Rev. Sci. Instr., 35: 608-12(May 1964).

An assembly of bending magnets and magnetic quadrupole lenses was found, which causes the axis of a beam of charged particles of momenta $p \pm \Delta p$ to be shifted from its original axis to a parallel line displaced from its original axis by a distance d. A study of this transport system demonstrates that it is possible to choose the parameters of the system in such a way that the entire system has an acceptable effect on the transverse motion of the beam, and so that the system is achromatic to first order in $\Delta p/p$. A typical transport system is given, and results are presented in graphical form for a range of parameters encompassing the typical values. (auth)

**22638** DAMPING OF A RESISTIVE WALL BEAM INSTABILITY IN THE COSMOTRON. M. Q. Barton, J. G. Cottingham, and A. Tranis (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 35: 624-5(May 1964). (BNL-7640)

In several particle accelerators the growth of coherent axial betatron oscillations was observed. In the Cosmotron these oscillations were damped by an electronic system that detects the axial beam position and applies a signal of proper strength and phase to a set of deflection electrodes. (auth)

**22639** CALCULATION OF THE SPHERICAL ABERRATION COEFFICIENT FROM BEAM EMITTANCE DIAGRAMS. A. Galejs and P. H. Rose (High Voltage Engineering Corp., Burlington, Mass.). Rev. Sci. Instr., 35: 644-5 (May 1964).

Beam transfer through a lens with and without aberrations is discussed. (R.E.U.)

**22640** STATUS REPORT OF I.P.C.R. 26" CYCLOTRON. BEAM STUDY OF THE ORDINARY CYCLOTRON. Takashi Karasawa and Akira Shimamura (Inst. of Physical and Chemical Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 39: 242-50(Nov. 1963). (In Japanese)

From 1960 to 1963, the acceleration mechanism was examined on the IPCR 26" cyclotron. In this report the operating condition of the cyclotron is described. The threshold voltage is calculated for two relative magnetic field distributions and the experimental results are shown. The reduction of the threshold dee voltage is advantageous for reliable operation. The divergence of the beam caused by vertical motion is measured and theoretical discussion is presented. Now the extracted beam is more than 50 μa and the fast neutron flux is $10^8 \sim 10^7$ as measured by the reaction of $^{107}Ag(n,2n)^{106}Ag$ on the Li target bombarded with 3.7-Mev deuterons. (Nucl. Sci. Abstr. of Japan, 3: No. 2, (Apr. 1964))

**22641** THE TRANSTRON ACCELERATOR S-1 (REPORT 1). Minoru Okada and Yoshiaki Arata (Osaka Univ.). Technol. Rept. Osaka Univ., 13: 289-96(Oct. 1963).

The power source and the accelerating tube in the first acceleration step of Transtron accelerator were designed and produced so as to generate in the duration of 10 μsec 1-Mev electron beam of 260 amp at the maximum rated electric power. The apparatus was operated under an acceleration voltage of 160 to 600 kv. The effect of a strong magnetic field on electron-beam diameter and radiant x-ray dose was investigated. (Nucl. Sci. Abstr. of Japan, 3: No. 2, (Apr. 1964))

**22642** THE ION BEAM ENERGY STABILIZATION SYSTEM OF THE VAN DE GRAAFF GENERATOR AT GOTHENBURG. J. Dubois. Trans. Chalmers Univ. Technol., Gothenburg, No. 270, 1-14(1963).

A brief description of the design and performance of the beam stabilization system used in the Van de Graaff generator is presented. (C.E.S.)

**22643** ON THE FOCUSING OF PARTIALLY SHIELDED MULTI-ELECTRODE ELECTRON GUN. Kuo-chu Ho (Nankai Univ., [Korea]). Wu Li Hsueh Pao, 20: 33-40(Jan. 1964). (In Chinese)

The problem of focusing a high-current electron beam in a multi-electrode electron gun with a magnetic field was analyzed theoretically. The cathode of the gun may be partially shielded magnetically The paraxial-ray equation for describing the electron trajectory in the accelerating region is solved in closed form. The space charge effect was included. (auth)

**22644** APPROXIMATION SOLUTION OF HILL'S EQUATION FOR ISOCHRONOUS CYCLOTRON. Shou-hsiang Fang and Sung-lan Sun. Wu Li Hsueh Pao, 20: 252-60(Mar. 1964). (In Chinese)

Approximation solutions and formula, developed on the basis of perturbation theory and constant variability were used for resolving Hill's equation indices. In second approximation (retaining the order $q_{R\gamma}^2$), the relative order of error does not exceed 0.2%. The obtained formulas were applied in theoretical studies with isochronous cyclotrons. (tr-auth)

**22645** EXPERIENCE IN ADJUSTING A MAGNETIC DEFLECTION AND ANALYSIS SYSTEM FOR THE DARMSTADT 60-Mev ELECTRON LINEAR ACCELERATOR. Hans-Georg Clerc and Helmut Liesem (Technische Hochschule, Darmstadt, Ger.). Z. Angew Phys., 17: 53-6(Feb. 196[illegible]. (In German)

The design of the Darmstadt Electron Linear Accelerator magnetic deflection and analysis system is described. The arrangement of the magnets resulted from mathematical consideration of the field boundary. The optical characteristics of the system were tested by the floating-wire method. Energy calibrations were obtained by three methods. (M.C.G.)

**22646** DIFFUSION LOSSES OF THE CARBON-11 NUCLEI DURING THE ACTIVATION OF PLASTIC FILMS BY HIGH-ENERGY PROTONS. B. I. Bekker, V. S. Pantuev, V. A. Sviridov, and M. N. Khachaturyan (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 46: 813-14(Feb. 1964). (In Russian)

The intensity of the internal proton beam in an accelerator may be determined by the activation of carbon-containing specimens, resulting in the formation of $^{11}C$ nuclei which can be detected by their β activity. However, losses caused by the creation of gaseous products were obtained when polyethylene and certain other carbon-containing materials were thus exposed to the accelerator beam. It was

found that the diffusion time of the gas, consisting mostly of $CH_4$, $C_2H_4$, $C_2H_2$, and $C_2H_6$, depends on the thickness of the sheet. An attempt was made to measure exactly the diffusion losses, in order to determine exactly the error in the activation analysis; therefore, small containers made of 0.2 to 20 mg/cm$^2$ polyethylene or ethylene–propylene copolymers were irradiated in the internal 9-Bev internal proton beam of the synchrophasotron; a 95 mg/cm$^2$ thick polystyrene plastic scintillator was placed in the specimens. The amount of $^{11}C$ nuclei in the wall of the specimen was determined by means of a scintillation counter. The average diffusion losses were found to amount to 11.8 ± 1%; it was also established that within a wide range, the losses were independent of the energy and the type of the bombarding particles. (TTT)

**22647** METHOD FOR OBTAINING VOLTAGE SYMMETRY OF THE THREE RADIOFREQUENCY CAVITIES AND FOR OBTAINING A HIGHLY CONSTANT FREQUENCY OF THE ACCELERATING VOLTAGE IN A CYCLOTRON OF THE THREE-SECTOR TYPE. Hans-Helmut Feldmann (to Licentia Patentverwatungs GmbH). German Patent 1,160,120. Dec. 27, 1963. Filed June 5, 1961.

For holding constant the frequency of the generator that provides the accelerating voltage, the operating frequency of a highly constant guide frequency is retrimmed. For obtaining equal resonant frequencies for each of the three resonators, frequency changers are installed that turn the equalizing currents flowing between the resonators into voltages of technical frequencies (50 Hz) and of equal amplitudes and phases. These voltages control the servomotors attached to the resonators. (Gmelin Inst.)

## Astrophysics and Cosmology

**22648** (AFCRC-TR-56-267) ATLAS OF REPRESENTATIVE COMETARY SPECTRA. Technical Final Report. P. Swings and L. Haser (Liege. Universite). [nd]. Contract AF61(514)-627. 83p.

Twenty-three plates of representative cometary spectra are presented accompanied by a short description of the main features and observational data such as heliocentric distances and instrumental conditions. (C.E.S.)

**22649** (JPRS-24435) PROBLEMS OF COSMOGONY. VOLUME VI. Translated from Vopr. Kosmogonii, Akad. Nauk SSSR, 6: 1-368(July 19, 1958). 412p. (OTS-64-31190)

Cosmological problems such as the origin of continents and oceans, age estimation, lunar properties, the growth of terrestrial planets, origin of the solar system; disintegration of light quanta, physics and dynamics of planetary nebulae, interaction between stars and diffuse matter, MGD processes, and element synthesis are discussed. Separate abstracts are prepared for 5 of the 15 papers presented. (C.E.S.)

*For abstracts of individual papers see: 22249, 22250, 22262, 22650, and 22651.*

**22650** (JPRS-24435(p.274-304) MAGNETOGASDYNAMICS AND PROBLEMS OF COSMOGONY. S. A. Kaplan. Translated from Vopr. Kosmogonii, Akad. Nauk SSSR, 6: (July 19, 1958). 30p.

The basic positions and main achievements of magnetogasdynamics—the existence of a freezing-in integral, the description of entanglement and disentanglement of magnetic lines of force in gasomagnetic shock waves, and the concept of gasomagnetic turbulence, are outlined. Cosmogonic hypotheses which in some degree or another make use of the methods and results of magnetogasdynamics are discussed. The hypothesis of a link between spiral arms and the regular magnetic field, the hypothesis of the formation of interstellar gas clouds as separate vortex cells of interstellar gasomagnetic turbulence, the hypothesis of the formation of a gaseous galactic halo as the result of magnetic pressure and the pressure of cosmic rays on magnetized interstellar space, the hypotheses of the formation of filimentary nebulae as the result of possible instability in gasomagnetic shock waves, the hypotheses of the formation of the magnetic fields of stars as part of the process of condensation, and the hypotheses of the acceleration of cosmic particles in a gasomagnetic medium are considered. (auth)

**22651** (JPRS-24435(p.309-15)) THE LOCATION OF AN EQUILIBRIUM THERMONUCLEAR MEDIUM. P. G. Parkhomenko. Translated from Vopr. Kosmogonii, Akad. Nauk SSR, 6: (July 19, 1958). 7p.

The mass of an object in which, under equilibrium conditions, the observed abundances of elements and isotopes could be established is determined. For a statistically equilibrium nuclear gas, values for temperature and nucleon concentrations determined for the isotopes of light elements are used. In the case of helium concentrations, plausible assumptions are made. The mass arrived at is approximately 2,000 times larger than the mass of the sun—that is, considerably smaller than the mass of the Galaxy and the Metagalaxy, lying between the masses of globular and open star clusters. (auth)

**22652** THE ORIGIN OF THE ELEMENTS. William A. Fowler (California Inst. of Tech., Pasadena). Chem. Eng. News, 42: 90-104(Mar. 16, 1964).

The origin of the elements in the universe is discussed. Astrophysical observations that support the theory of e-process in stars are described. (P.C.H.)

**22653** SOLAR COSMIC RAY EVENTS DURING LATE AUGUST 1957. Kinsey A. Anderson (Univ. of California, Berkeley). J. Geophys. Res., 69: 1743-53(May 1, 1964).

Reanalysis of radio wave observations of PCA events and balloon measurements of energetic particles leads to the conclusion that two instead of three solar cosmic ray events occurred during late August 1957. This revision involves different flare assignments, and the balloon data show that the delay time between flare beginning and the first arrival of particles at the earth is much less than was reported previously on the basis of radio wave measurements. An importance 3 flare on August 28, 1957, began at 2010 UT. This flare is the most likely source of the solar cosmic rays that began to arrive at the earth after 2140 UT on August 28. Evidence found for an event beginning on August 29, is uncertain. The second cosmic ray event that can be identified during this period began at 1340 UT on August 31. The associated flare is probably the one that began at 1257 UT on this date. (auth)

**22654** DETERMINATION OF LEAD IN METEORITES BY ALPHA ACTIVATION ANALYSIS. James C. Cobb (Brookhaven National Lab., Upton, N. Y.). J. Geophys. Res., 69: 1895-1901(May 1, 1964).

Alpha activation analysis was applied to the problem of lead isotopic abundances in meteorites. The procedure involves the bombardment of samples with 30-Mev alpha particles to induce an $(\alpha,2n)$ reaction on the lead isotopes. This produces radioactive polonium isotopes that may be isolated and counted. Relative abundances of $^{208}Pb$, $^{206}Pb$, and $^{204}Pb$ were measured on four stone meteorites, a troilite, and a terrestrial basalt. Lead from troilite of the iron meteorite had an isotopic composition, $^{208}Pb/^{204}Pb$ =

38.0 ± 1.7 and $^{208}Pb/^{206}Pb = 2.2 \pm 0.07$, similar to that reported by Starik in several iron meteorites. This is distinct from the isotopic composition $^{208}Pb/^{204}Pb = 29.5$ and $^{208}Pb/^{206}Pb = 3.1$ found in other iron meteorites. The result confirms previous reports that these two kinds of lead can exist in different parts of the same meteorite. The results for the stone meteorite samples show a more radiogenic lead than can be accounted for by their lead to uranium and lead to thorium ratios. These measurements do not support the assumption that stone meteorites, when they crystallized, incorporated lead of the same isotopic composition. However, there is evidence of contamination of the meteorite lead with a few tenths of a ppm terrestrial lead, which could explain this discrepancy. (auth)

**22655** SPUTTERING OF METEORITES BY $He^+$, $Ne^+$, AND $Ar^+$ IONS. Dieter Heymann (FOM Lab. for Mass Separation, Amsterdam). J. Geophys. Res., 69: 1941-3 (May 1, 1964).

The erosion rates for the sputtering of meteorites by $He^+$, $Ne^+$, and $Ar^+$ ions at 20 kev were calculated. The sputtering coefficients were also obtained. (C.E.S.)

**22656** γ RADIOACTIVITY IN THE FAYETTEVILLE METEORITE. M. W. Rowe and O. K. Manuel (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 69: 1944-5 (May 1, 1964).

The gamma activity of the Fayetteville meteorite was measured. This data was used to calculate the $^{40}K-^{40}Ar$ gas retention age and the $^{21}Ne-^{26}Al$ cosmic ray exposure age of the meteorite. (C.E.S.)

**22657** THE KINEMATICS OF GASEOUS NEBULAE AND SUPERGIANT STARS IN THE MAGELLANIC CLOUDS. M. W. Feast (Radcliffe Observatory, Pretoria). Monthly Notices Roy. Astron. Soc., 127: 195-214(1964).

Radial velocities of 42 regions of emission nebulosity in the LMC and 2 in the SMC, derived from coudé spectrograms (15.6 Å/mm), are listed, together with 9 velocities in the galactic nebula M8. The results are compared with previous work. Representation of the radial velocities of 43 LMC nebulae by solid body motion yields results closely similar to a previous solution for 61 supergiants. The p.a. of the major axis of the LMC is again found close to 171°. The combined results of nebulae and stars now show differential rotation rather clearly. The optical and 21-cm rotation curves agree quite closely and define a center of symmetry displaced 1°N of the optical bar of the LMC. With an inclined plane model (i = 27°) the mass of the LMC falls between 1.0 and $0.5 \times 10^{10}$ solar masses. A velocity dispersion of 9.6 ± 1.1 (s.e.) km/sec is derived for nebulae and supergiants in the LMC indicating that these objects are probably concentrated to a plane. The velocity dispersion is not significantly different from this in groups of apparently related nebulae or within the 30 Doradus nebula. Five supergiants in the LMC and 5 in the SMC have large velocity residuals. These stars seem similar to the high velocity O-type stars in the Galaxy since (1) they have evolved from O-type stars (2) the percentage of high velocity stars (10 per cent) is the same as for galactic O-types (3) the mean residual velocities of these stars are closely similar in the Magellanic Clouds and the Galaxy. The significance of this result is briefly discussed and it is pointed out that in the Galaxy the percentage of high velocity stars is apparently much higher amongst the Of stars than amongst O stars in general. (auth)

**22658** THE IONIZATION STRUCTURE OF PLANETARY NEBULAE. III. THE IONIZATION OF HELIUM. D. G. Hummer and M. J. Seaton (University Coll., London). Monthly Notices Roy. Astron. Soc., 127: 217-40(1964).

In planetary nebulae the helium to hydrogen abundance ratio, by numbers of atoms, is Y = 0.1 to 0.2; the abundance of heavier elements, by numbers of atoms relative to hydrogen, is $Z \sim 10^{-3}$. The heavier elements may be neglected when considering the ionization of hydrogen and helium, but are of importance in considering the thermal balance. Three main regions are considered. In region (i), that is, the innermost region, the most abundant ions are $He^{2+}$ and $H^+$. The $He^{2+}-He^+$ ionization equilibrium is calculated by the method of Paper I. In region (ii) the most abundant ions are $He^+$ and $H^+$. The $He^+-He^0$ and $H^+-H^0$ ionization equilibria are calculated on solving coupled equations. In region (iii) none of the gas is ionized. This region exists only if the total amount of gas is sufficient to produce absorption of all ionizing stellar quanta. (auth)

**22659** INTERPRETATION OF THE COUNTS OF RADIO SOURCES IN TERMS OF A 4-PARAMETER FAMILY OF EVOLUTIONARY UNIVERSES. W. Davidson and M. Davies (Battersea Coll. of Tech., London). Monthly Notices Roy. Astron. Soc., 127: 241-55(1964).

A family of evolutionary cosmological models, characterized by four physical or kinematical parameters, is formulated and their exact theoretical number counts are calculated by computer to compare with the observed data of the Cambridge surveys and individual polar counts by Pyle and Neville. The analysis is confined to the case when radio source density is proportional to galaxy density at all epochs. It is found that within the assumed formulation there is a number count curve that will fit the observed data. (L.B.S.)

**22660** THE GALACTIC FORCE AND STELLAR KINEMATICS PERPENDICULAR TO THE GALACTIC PLANE: O AND B STARS. R. Stothers and J. L. Tech (Harvard Univ., Cambridge, Mass.). Monthly Notices Roy. Astron. Soc., 127: 287-300(1964).

The component of the galactic force field perpendicular to the galactic plane in the solar neighborhood is found by direct use of the definition of K(z) in terms of the gradient of the kinetic energy and a plot of z against $\dot{z}$ for the O and B stars. This method yields a force law, linear to about x = 200 pc, that gives about the same magnitudes and period of oscillation as methods that have explicitly used star counts. The assumption of a gaussian velocity distribution in the effective galactic plane (z = ±40 pc) is found to be reasonable, and the most probable speed decreases linearly from 20 km/sec at z = 0 to 6 km/sec at z = 200 pc. O and B stellar distributions at various z are in accord with kinematical ages (time spent in orbit from the galactic plane), evolutionary ages, and the derived period of oscillation. (auth)

**22661** THE INVERSE COMPTON EFFECT AS A POSSIBLE CAUSE OF THE X-RAY RADIATION OF SOLAR FLARES. Joseph Shklovskii (Moscow State Univ.). Nature, 202: 275-6(Apr. 18, 1964).

The x radiation of solar flares is explained by non-equilibrium processes, most pronounced of which is the inverse Compton effect. It is also noted that the inverse Compton effect may be a very efficient mechanism for the hard photon emission of some types of stars. (P.C.H.)

**22662** CHONDRITIC EARTH MODEL. S. R. Taylor (Australian National Univ., Canberra). Nature, 202: 281-2(Apr. 18, 1964).

Problems and consequences of the chondritic Earth model are discussed. The simplest interpretation is that the Earth contains less of the alkali elements than the chondrites, and less Cs relative to Rb and K. It is apparent from previous data that the chondritic model does

not provide enough uranium and thorium by a factor of about two to account for the abundances in the continental crust. A restriction of the total abundances of the heat-producing elements, U, Th, and K, is provided by the flow of heat from the Earth. The possibility of lateral transport of U and Th from the sub-oceanic to the sub-continental mantle, with subsequent upward concentration in the continental crust, cannot be considered likely because of the similarity of oceanic and continental heat flows. It was concluded that although serious difficulties exist for the chondrite model, the problems discussed do not constitute reasons for its outright rejection. (P.C.H.)

**22663** NATURE OF STRONG RADIO EMISSION FROM QUASI-STELLAR OBJECTS. L. Gold and J. W. Moffat (Research Inst. for Advanced Studies, Baltimore). Phys. Letters, 9: 138-9(Apr. 1, 1964).

The quasi-stellar objects are considered as fully ionized high temperature plasma, and it is shown that the plasma system is in the region of instability and is expected to radiate energy in the form of radio waves. The total free electrostatic energy, the mass density, the radius of the quasi-stellar system, and the Schwartzschild critical radius are estimated. (L.B.S.)

**22664** NEUTRON-HYPERON STARS. Br. Kukhovich. Postepy Astron., 11: 203-14(1963). (In Polish)

A review of the problem of neutron-hyperon stars, based on three papers by Ambartsumian and Saakyan is presented. Ambartsumian's hypothesis of the superdense state of prestellar matter is considered, and the results of calculations of equilibrium configurations of a superdense degenerate baryon gas are discussed. (auth)

**22665** A LABORATORY ASPECT OF COSMOLOGY. Br. Kukhovich. Postepy Astron., 11: 255-61(1963). (In Polish)

A laboratory experiment is suggested that could test certain cosmological theories. From those theories it follows that the universe is filled with a shallow degenerate Fermi sea of neutrinos. The neutrino levels are filled up to a finite Fermi energy $E_F$. Experiments determining the shape of the allowed beta spectrum can be used to determine $E_F$. In the steady state and big-bang cosmologies $E_F$ is much too low to ever be observed, but in the oscillating cosmology $E_F \simeq 5 R_c$ (Mev), where $R_c$ is the minimum radius of the universe in units of its present radius. Experimental data suggest that the universe will contract by a factor over $10^3$, if at all. (auth)

**22666** ON THE AVOIDANCE OF SINGULARITIES IN C-FIELD COSMOLOGY. F. Hoyle (St. John's Coll., Cambridge, Eng.) and J. V. Narlikar. Proc. Roy. Soc. (London), Ser. A, 278: 465-78(Apr. 21, 1964).

It is well known that a spherically symmetric imploding cold body collapses into a space-time singularity in general relativity. The singularity does not arise, however, in the modification of the theory proposed in C-field cosmology. Although the C-field was used to represent creation of matter, the prevention of singularities does not depend on the creation property of the field, but on its negative energy density. It does not seem that singularities can be prevented except by a negative energy field. Internal pressures of the ordinary kind fail to provide support against gravitation provided the mass of the body is sufficiently large. (auth)

**22667** BIRTH OF THE ELEMENTS. A. G. W. Cameron (Goddard Inst. for Space Studies, New York). Sky Telescope, 25: 254-7(May 1963).

A quantitative argument is given that supports the theory that the chemical elements were born instead of having existed for an infinite length of time. The theory that there has been a gradual building up of the heavier elements by nuclear reactions in stellar interiors is discussed at length. (P.C.H.)

## Atomic Physics

**22668** (AD-417241) MUON CAPTURE IN CHEMICAL COMPOUNDS (thesis). Roy Eugene Herman (Utah. Univ., Salt Lake City). Aug. 1963. 29p.

The law governing the probability that a muon should come to rest on a particular atom in a chemical compound was investigated using $SiO_2$ and $P_2O_5$. The observed O/P and O/Si stopping ratios were in agreement with the stoichiometric ratios of the compounds. (auth)

**22669** (AROD-3331:5) DIFFUSION EXPERIMENT TO DETERMINE CERTAIN CROSS SECTIONS FOR COLLISIONS BETWEEN ELECTRONS AND GASES. Final Report. B. T. McClure (Honeywell Research Center, Hopkins, Minn.). Mar. 31, 1964. Contract DA-31-124-ARO (D)-96 and DA-11-022-ORD-4157. 9p.

Interactions between low-energy electrons and the gases He, Ne, Ar, $H_2$, and $N_2$ were studied by a diffusion technique. Results for inelastic nonionizing momentum-transfer cross sections are given for He, Ne, and Ar. Total inelastic nonionizing cross-section results are reported for all the gases. (M.J.T.)

**22670** (LA-3056) SCATTERING FACTORS COMPUTED FROM RELATIVISTIC DIRAC-SLATER WAVE FUNCTIONS. D. T. Cromer and J. T. Waber (Los Alamos Scientific Lab., N. Mex.). Jan. 1964. Contract W-7405-eng-36. 222p.

Scattering factors for a total of 208 neutral atoms, positive ions, and a few negative ions are given in tabular form and as nine-parameter analytic functions. These scattering factors have been computed from relativistic self-consistent field wave functions which include Slater's approximate exchange correction. (auth)

**22671** (UCRL-7088(Rev.I)) RADIATIVE TRANSITION PROBABILITIES IN HYDROGEN. John R. Hiskes and C. Bruce Tarter (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 15, 1964. Contract W-7405-eng-48. 216p.

The radiative transition probabilities in hydrogen were calculated for all possible transitions through n = 25 in both spherical coordinates (field free case) and parabolic coordinates (Stark case). In spherical coordinates the transition probabilities are a function only of n and l, while in parabolic coordinates they are in general functions of all three parabolic quantum numbers, $n_1$, $n_2$, and m. For $m > 0$, and to within an error of the order of 1%, the Stark transition probabilities are a function only of n and m. Tables listing the total transition probability for all states through n = 25 in both sets of coordinates, and the individual transition probabilities through n = 10 in the parabolic case, and through n = 25 in the spherical case, are given. The radiative lifetimes are presented graphically. A brief discussion is given of the range of applicability of the transition probabilities. (auth)

**22672** (ANL-Trans-16) SOLUTION OF SIMPLIFIED FOCK EQUATIONS IN BICONFIGURATIONAL APPROXIMATION FOR THE BERYLLIUM-TYPE OF ATOMS. A. P. Yutsis, V. V. Kibartas, and I. I. Glembotskii. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Eksperim. i Teor. Fiz., 27: 425-30(1954). 8p.

The Fock equations were simplified in biconfigurational

approximation by neglecting the configurational members in equations corresponding to equations of the studied configuration and by neglecting the exchange member in equations corresponding to the equations of the considered configuration. Solutions of such simplified equations for the basic configuration of $B^+$ and $C^{2+}$ ions are discussed. By means of the solutions for simplified Fock equations, in biconfigurational approximation $1s^22s^2 - 1s^22p^2$ the values of the total energy of Be, $B^+$ and $C^{2+}$ were determined and compared with the experimental data. (auth)

**22673** SPUTTERING OF POLYCRYSTALLINE COPPER AND SILVER BY 30–170 kev ARGON IONS. C. E. Ramer, Musti A. Narashimham, H. K. Reynolds, and J. C. Allred (Univ. of Houston, Tex.). J. Appl. Phys., 35: 1673-80(June 1964).

Polycrystalline copper and silver were sputtered by 30–170 kev singly ionized argon at various beam angles, and total yields (atoms/ions) were measured as a function of energy and incident angle. Angular distributions of sputtered material about the target normal indicate a distribution approximately proportional to the cosine of the angle of emission, but with more material collected in the normal direction than for a strict cosine distribution. No significant variation of angular distribution with ion energy or with sputtering beam angle was observed. The yield appears to be independent of pressure, collector temperature, current, and current density. Erratic results were obtained when the target was not water cooled, and when the glass collector plates were not initially coated with a thin layer (~50 Å) of evaporated metal. (auth)

**22674** ENERGY DISTRIBUTION OF SPUTTERED Cu ATOMS. R. V. Stuart and G. K. Wehner (Applied Science, Minneapolis). J. Appl. Phys., 35: 1819-24(June 1964).

Energy distributions were obtained for atoms sputtered from Cu (100), (110), (111), and polycrystalline surfaces bombarded by 80- to 1200-ev Hg and noble gas ions. Energies of sputtered atoms are found to depend markedly on the angle of ejection. For a (110) surface bombarded by 1000-ev Kr ions, average energies of ejected atoms are 9.5 ev in the [110] direction (normal to the surface) and 14.2 ev in the [011] direction (60° to the surface normal). Ejection energies decrease for lighter ions in the order $Kr^+$, $Ar^+$, $Ne^+$, and $He^+$. For a (110) surface bombarded by 600-ev He ions, the average energy of atoms ejected in the [110] direction is 5.5 ev. Dependence on bombarding ion energy is very weak above 1000 ev where average energies of sputtered atoms are found to be in the range 5–15 ev. Ejection energies decrease at lower bombarding ion energies and decrease rapidly below 200 ev. For atoms ejected in the [110] direction from a (110) surface under Kr ion bombardment, the average energy decreases from 5.5 ev at an ion energy of 200 ev to 2.6 ev at an ion energy of 80 ev. (auth)

**22675** ENERGY LEVELS OF Am IV IN $LaCl_3$. John G. Conway (Univ. of California, Berkeley). J. Chem. Phys., 40: 2504-7(May 1, 1964). (UCRL-11099)

It was possible to assign the 10 lowest energy levels of Am(IV). By using these assignments and the complete spin-orbit matrices, a fit was obtained with 5f hydrogenic wavefunctions. The fit was then improved by using a fitting program and varying all four parameters. Comparison calculations using hydrogenic wavefunctions were made for Pu(I). For Am(IV) the hydrogenic values are $F_2 = 268.6$ cm and $\zeta = 2605$ cm$^{-1}$; the corresponding values for Pu I are $F_2 = 230.6$ and $\zeta = 2174.6$ cm$^{-1}$. (auth)

**22676** SCATTERING OF ATOMIC BEAMS BY POLYCRYSTALLINE NICKEL. Joe N. Smith, Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 40: 2520-7(May 1, 1964).

The results of recent experimental studies of the scattering of beams of Kr, Ar, Ne, He, and $D_2$ from carbonized polycrystalline nickel targets are presented and compared with the findings of other investigations of the phenomenology of heavy particle scattering at a solid surface. Utilizing alkali–halide cleavage planes, large deviations from diffuse (cosine law) scattering were observed, which have not yet been satisfactorily interpreted. The experiments tend to support a model for the scattering mechanism in which a fraction of the incident molecules are scattered diffusely and the remainder are scattered preferentially. From experimental observations, it is inferred that the slower particles in the incident beam contribute to the diffuse component while the faster particles are scattered preferentially. In addition, an angular variation in the degree of thermal accommodation of the incident particles was observed. (auth)

**22677** A QUANTUM MECHANICAL STUDY OF THE He, $H^-$, He–He AND He–H SYSTEMS. H. S. Taylor and F. E. Harris (Univ. of California, Berkeley). Mol. Phys., 7: 287-95(1963-64).

The previously described methods for treating diatomic molecules are applied to the interaction of two normal helium atoms and the interaction of a normal helium atom and a hydrogen atom. The results are compared to the experimental results of Amdur and referred to other theoretical results where they exist. The results on the He–H interaction are in fair agreement with Amdur's experimental work. The repulsive potential of two normal helium atoms disagrees with Amdur's experimental results at the distances between 1 and 2 angstroms. The helium atom and negative hydrogen ion are also discussed. (auth)

**22678** THEORY OF NON-ADIABATIC VIBRATIONAL RELAXATION IN ATOM-MOLECULAR COLLISIONS. I. WEAK SPIN-ORBITAL COUPLING. E. E. Nikitin (Inst. of Chemical Physics, Moscow). Mol. Phys., 7: 389-96(1963-64).

The transition complex method is used for calculating the rate constant of non-adiabatic vibrational deactivation of diatomic molecules in the $^2\pi$ electronic state upon collisions with inert gas atoms. The main contribution to the rate constant comes from vibronic transition caused by spin–orbital and orbital–rotational couplings. The two-dimensional Landau–Zener approximation is considered in connection with calculation of the non-adiabatic transition near the crossing line of two potential surfaces, and the limitations of ideas concerning the activated complex are discussed. The general experession for the constant derived from the diatomic molecule-atom collision is correlated with that for the atomic collision. (auth)

**22679** ROLE OF THE THALLIUM DIMER IN THE NaI(Tl) SCINTILLATION PROCESS. W. J. Van Sciver (Lehigh Univ., Bethlehem, Penna.). Phys. Letters, 9: 97-8(Apr. 1, 1964).

Evidence for the existence of the dimer in NaI(Tl) is summarized. It is shown by analysis of a typical emission spectrum for crystals excited by $^{60}$Co gamma rays that the dimer is more effective than the thallium monomer in capturing and converting energy dissipated in the host crystal lattice by a high energy ionizing particle. It is conjectured that the role of the thallium dimer in the scintillation process is exciton capture. (L.B.S.)

**22680** FAST ELECTRON EXCITATION VIBRATION TERMS OF MOLECULAR HYDROGEN. H.-J. Reich and

H. Schmoranzer (Technische Universität, Berlin). Phys. Letters, 9: 127-8(Apr. 1, 1964).

The strong intensity emissions from molecular hydrogen excited by 15-kev electrons were studied by vacuum spectroscopy. The resulting spectrum shows transitions of the $2p^1\pi_\mu$, $2p^1\Sigma^+$, and $3p^1\pi\mu$ electronic states, and corresponding vibration terms are compared with results of energy loss measurements. (L.B.S.)

**22681** QUADRUPOLE MOMENT OF THE HYDROGEN MOLECULE BY THE METHOD OF THE MODIFIED SCHRÖDINGER EQUATION. E. Corinaldesi and G. J. Hurford (Univ. of Toronto). Phys. Letters, 9: 135(Apr. 1, 1964).

It is shown that the quadrupole moment of the hydrogen molecule obtained from the modified Schroedinger equation is in close agreement with the value given by Kolos and Roothaan when the arbitrary parameter, $\alpha$, in the equation is taken to be 1.07. (L.B.S.)

**22682** INTERPRETATION OF FREQUENCY SHIFTS DUE TO ELECTRON EXCHANGE COLLISIONS. P. L. Bender (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 134: A1174-80(June 1, 1964).

Experiments by Hobart and Franken in 1961 demonstrated a shift in the free-electron spin-resonance frequency due to collisions with sodium atoms whose electron spins were polarized. The results were interpreted on the assumptions that the S-wave shifts were proportional to the wave number k and that higher partial waves were not important. The triplet and singlet electron-sodium scattering lengths of Salmona and Seaton were used, but no check on the calculation was made since the sodium polarization was not known. Recently Balling, Hanson, and Pipkin measured the shift for collisions with highly polarized rubidium atoms. They also derived complete formulas for the frequency shift and line broadening in terms of the phase shifts with all partial waves included. An alternate derivation of the frequency shift and line broadening formulas is given, and the experimental results are discussed on the basis of the phase-shift information that is available for hydrogen, sodium, and cesium. The small size of the observed ratio of frequency shift to line broadening for rubidium appears somewhat surprising in view of the larger ratios calculated for other alkalies. (auth)

**22683** FINE STRUCTURE OF HELIUM. Charles Schwartz (Univ. of California, Berkeley). Phys. Rev., 134: A1181-7(June 1, 1964).

Under the expectation that experiments will soon give values for the fine structure intervals of the $2^3P$ state of helium to an accuracy of $1/10^6$, a program of calculations was undertaken which, it is hoped, will lead to a new determination of the fine-structure constant $\alpha$. A brief survey of the overall program, and a detailed report of the successful completion of the construction of approximate solutions to the Schrödinger equation that lead to average values of the leading fine structure operators accurate to about one part per million are given. (auth)

**22684** LOW-ENERGY EXPANSION OF THE SCATTERING AMPLITUDE FOR LONG-RANGE QUADRUPOLE POTENTIALS. Thomas F. O'Malley (Joint Inst. for Lab. Astrophysics, Boulder, Colo). Phys. Rev., 134: A1188-97 (June 1, 1964).

For static potentials that are proportional asymptotically to $qP_2(\cos\theta)/r^3$, the low-energy expansion of the scattering amplitude is found through terms of O(k), using a modification of the method developed by Levy and Keller for central potentials. The resulting expansion to lowest order in k is found to be $f(\theta,\phi) \sim -A + (q/3)\,P_2(\cos\theta_K) + O(k)$, where A is the scattering length and $\theta_K$ is the coordinate of the momentum transfer vector. Applications are attempted first to electron-atom elastic scattering where results are somewhat more complicated than for the potentials above, secondly to transitions between magnetic quantum states of atoms caused by slow electrons. (auth)

**22685** LIFETIME OF THE FIRST $^1P_1$ STATE OF ZINC, CALCIUM, AND STRONTIUM. Allen Lurio, R. L. deZafra, and Robert J. Goshen (Columbia Univ., New York). Phys. Rev., 134: A1198-1203(June 1, 1964).

The lifetime of the first excited $^1P_1$ state of zinc, calcium, and strontium was measured by the zero-field level-crossing technique. The results are: zinc $\tau(^1P_1) = 1.41 \pm 0.04 \times 10^{-9}$ sec, calcium $\tau(^1P_1) = 4.48 \pm 0.15 \times 10^{-9}$ sec, and strontium $\tau(^1P_1) = 4.97 \pm 0.15 \times 10^{-9}$ sec. The results are compared to earlier experimental results and also to theoretical predictions. It is found that the results are in excellent agreement with the Bates and Damgaard Coulomb approximation method for estimating the oscillator strengths. (auth)

**22686** $g_J$ OF THE (5s5p) $^3P_1$ LEVEL OF Cd AND THE (6s6p) $^3P_1$ LEVEL OF Hg BY HIGH-FIELD DOUBLE RESONANCE. R. Kohler (Columbia Univ., New York and New York Univ., New York) and P. Thaddeus. Phys. Rev., 134: A1204-9(June 1, 1964).

An optical double resonance experiment at high magnetic fields determined $g_J$ for the (5s5p) $^3P_1$ level of the even cadmium isotopes to be 1.499846(13), and $g_J$ for the (6s6p) $^3P_1$ level of the even mercury isotopes to be 1.486094(8). Resonance was observed in all cases at a frequency of exactly 24 Gc, and magnetic fields near 11,430 G. At these high fields the Zeeman energy is of the order of $10^{-3}$ of the fine structure separations of the triplet terms of the (nsnp) configuration, and the $\Delta m = \pm 1$ transitions are split by 9.51(7) G for Cd, and by 2.99(7) G for Hg. This splitting represents several linewidths in the case of Hg, and many linewidths in that of Cd. The average field of the two $\Delta m = \pm 1$ transitions, however, determines $g_J$ to high precision independent of second-order corrections. (auth)

**22687** DETERMINATION OF THE POLARIZABILITY TENSORS OF THE MAGNETIC SUBSTATES OF $^3P_2$ METASTABLE ARGON. Edward Pollack, Edward J. Robinson, and Benjamin Bederson (New York Univ., New York). Phys. Rev., 134: A1210-15(June 1, 1964).

The atomic beam E-H gradient-balance method was employed to measure the z-component $\alpha_z(m_J)$ of the electric polarizability tensors of the $m_J = +2$ and +1 magnetic substates of $^3P_2$ metastable argon. The measurements were normalized to the polarizability of $^3S_1$ metastable helium, which is calculable to within an accuracy of 1%. In this method, a metastable beam is passed through a region containing transverse, congruent, inhomogeneous electric and magnetic fields. The condition that atoms in a particular magnetic substate experience no deflection in such a field region is $\alpha_z(m_J)E(\delta E/\delta z) = \mu_{eff}(\delta H/\delta z)$, where $\mu_{eff}$ is the magnetic moment in the field H, and $\delta E/\delta z$, $\delta H/\delta z$ are the components of the gradients of the magnitudes of the electric and magnetic fields, respectively. Because of the congruency of the E and H fields $(\delta E/\delta z)/E = (\delta H/\delta z)/H$, and therefore $\alpha_z(m_J) = \mu_{eff}H/E^2$. Because of the normalization, it was unnecessary to find either E or H. The results, in units of $10^{-24}$ cm$^3$, are $\alpha_z(\pm 1) = 50.4 \pm 3.5$ and $\alpha_z(\pm 2) = 44.5 \pm 3.1$. The measured values of $\alpha_z(+1)$ and $\alpha_z(+2)$ can be used to determine the polarizability tensors of each of the magnetic substates. The other components of the diagonalized tensors, with $\alpha_x(m_J) = \alpha_y(m_J)$ in units

of $10^{-24}$ cm$^3$ are $\alpha_x(0) = 46.4 \pm 2.4$, $\alpha_x(\pm 1) = 47.2 \pm 2.3$, $\alpha_x(\pm 2) - 50.4 \pm 3.5$, and $\alpha_z(0) = 52.4 \pm 4.8$. (auth)

**22688** IONIZATION AND DISSOCIATION OF FAST $H_2$ MOLECULES INCIDENT ON $H_2$ GAS. G. W. McClure (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 134: A1226-34(June 1, 1964).

The yield cross sections $\sigma_{H_2^+}$, $\sigma_{H^+}$, and $\sigma_H$ for production of fast $H_2^+$ and $H^+$ ions and H atoms resulting from the ionization and dissociation of fast $H_2$ molecules in single collisions with $H_2$ gas molecules were measured in the 6- to 120-kev energy range (collision velocity 0.7 to $3.2 \times 10^8$ cm/sec). The neutral primary beam contained a fraction of H atoms which was determined by proportional counter analysis. Secondary particles produced by the H atoms in the primary beam were determined in separate H beam experiments and subtracted from the composite $(H,H_2)$ neutral beam data to yield the production of secondaries due to $H_2$ primaries alone. Cross section $\sigma_{H_2^+}$ increases monatonically from 0.5 to 2.0 Å$^2$ in the energy range 6 to 120 kev while $\sigma_{H^+}$ increases from 0.28 Å$^2$ at 7.5 kev to a maximum of 0.70 Å$^2$ at 50 kev. Cross section $\sigma_H$, measured only at 10 kev, was found to have an approximate value of 2.5 Å$^2$ based on an assumed shape of the H atom angular distribution at small angles. The results are compared with data on a number of collision processes in the same velocity range involving various species of hydrogen ions and H atoms incident on $H_2$ gas molecules. (auth)

**22689** KINETIC SECONDARY ELECTRON EJECTION FROM TUNGSTEN BY CESIUM IONS. Samuel H. Bosch and Guntis Kuskevics (Electro-Optical Systems, Inc., Pasadena, Calif.). Phys. Rev., 134: A1356-8(June 1, 1964).

Initial measurements of the number of electrons ejected per incident ion, $\gamma_i$, were made for medium-energy (1–21 kev) cesium ions at normal incidence on a clean polycrystalline tungsten surface. The residual gas pressure was $\leq 5 \times 10^{-9}$ torr. The tungsten surface was cleaned by prolonged bakeouts and by flashing before each measurement. A d-c ion-beam pulse method of measurement was used to prevent cesium coverage of the tungsten surface. In the energy range of 3–21 kev $\gamma_i$ is a linear function of the ion kinetic energy with $\partial\gamma_i/\partial E \simeq 0.04$ electron per ion per kev. At 3 and 21 kev $\gamma_i$ is 0.02 and 0.74, respectively. If the data are extrapolated to $\gamma_i = 0$, a threshold energy of 2.5 kev is obtained. Below this energy the measured values of $\gamma_i$ were equal to zero within the accuracy of the measurement. The change of $\gamma_i$ with cesium adsorption on the tungsten was also recorded. (auth)

**22690** METASTABLE HYDROGEN ATOMS PRODUCED IN CHARGE EXCHANGE. Bailey L. Donnally, Thomas Clapp, William Sawyer, and Margaret Schultz (Lake Forest Coll., Ill.). Phys. Rev. Letters, 12: 502-3 (May 4, 1964).

An experiment to produce metastable hydrogen atom beams from proton bombardment of cesium was undertaken. The cross section for the nearly resonant reaction $H^+ + Cs \rightarrow H(2s) + Cs^+$ for energies from 0.16 to 3 kev was measured. (M.J.T.)

**22691** SCATTERING MATRIX AND SURFACE MODES. [PART] I. Jun-ichi Hori and Takashi Asahi (Hokkaido Univ., Japan). Progr. Theoret. Phys. (Kyoto), 31: 49-66 (Jan. 1964).

It is shown that the scattering-matrix method is very useful for investigating the vibrational surface mode of crystal lattices. The following examples are treated: (1) a 1D lattice with one or two isotopic impurities at one of its ends; (2) a diatomic linear chain with or without an impurity at its end; (3) a 2D lattice one of whose edges is composed entirely of isotopic impurities of the same kind; (4) a 2D lattice with an isotopic impurity on one of its edges. In the diatomic-lattice case, an interesting result is obtained for the manner of appearance of the surface modes. Some discussions are given on the relation between the methods of the scattering matrix and the transfer matrix. (auth)

**22692** DETERMINATION OF OSCILLATOR STRENGTHS BY LIFETIME MEASUREMENTS OF THE FIRST EXCITED LEVELS OF THE ELEMENTS Ba, Sr, Ca, In, AND Na. E. Hulpke, E. Paul, and W. Paul (Universität, Bonn). Z. Physik, 177: 257-68(1964). (In German)

The lifetimes of the first excited state of the elements Ca, Sr, Ba, In, and Na were measured. Oscillator strengths (f) of resonance lines were computed from the measured lifetimes ($\tau$). The measurements were corrected for imprisonment of radiation in the investigated vapor. The error of the $\tau$-values was estimated to be approximately three percent. Results are: lifetimes for Ca 4 $^1P_1$ $(4.67 \pm 0.11) \cdot 10^{-9}$ sec; Sr 5 $^1P_1$ $(4.56 \pm 0.21) \cdot 10^{-9}$ sec; Ba 6 $^1P_1$ $(8.36 \pm 0.25) \cdot 10^{-9}$ sec; In 6 $^2S_{\frac{1}{2}}$ $(8.531 \pm 0.085) \cdot 10^{-9}$ sec; and Na 3 $^2P$ doublet $(1.59 \pm 0.039) \cdot 10^{-8}$ sec. For the Na 3 $^2P$ doublet the dependency of the lifetime on the pressure of foreign gases ($N_2$, $C_3H_8$, $C_6H_5-CH_3$) was studied. (auth)

**22693** CONCERNING BENT-CRYSTAL SPECTROMETER MEASUREMENTS OF K $\alpha$ X RAYS FROM RADIOACTIVE SOURCES. E. N. Hatch (California Inst. of Tech., Pasadena and Universität, Heidelberg). Z. Physik, 177: 337-47(1964).

The wavelengths of several K $\alpha$ x rays emitted from elements in and neighboring the rare earth region, which were contained in radioactive sources, have been determined with the two-meter quartz bent-crystal spectrometer. The results of the measurements in XU are the following: Sm K $\alpha_2$, 313.043; Sm K $\alpha_1$, 308.390; Eu K $\alpha_2$, 302.477; Eu K $\alpha_1$, 297.824; Gd K $\alpha_2$, 292.432; Gd K $\alpha_1$, 287.746; Tm K $\alpha_2$, 248.592; Tm K $\alpha_1$, 243.859; Yb K $\alpha_2$, 240.934; Yb K $\alpha_1$, 236.184; Lu K $\alpha_2$, 233.610; Lu K $\alpha_1$, 228.834; Hf K $\alpha_2$, 226.605; Hf K $\alpha_1$, 221.805. The estimated maximal error for each measurement is ±0.015 XU. From comparing the present measurements with precise measurements of the corresponding x rays from the naturally occurring elements, it can be concluded that there are no observable shifts in the x rays from the radioactive sources within 0.017 XU. An upper limit of 2.5 ev is obtained for an observable shift due to the isotope shift or the isomeric shift in the Gd K $\alpha$ x rays from a radioactive Eu source. Upper limits for the observation of shifts due to the isomeric shift in the K $\alpha$ x rays of 2.5 ev for Sm and 4 ev for Tm and Lu are also obtained. (auth)

**22694** ON THE INFLUENCE OF QUADRUPOLE TRANSITIONS ON THE X-RAY SPECTRA OF MUON ATOMS. Bjoern Wiik (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 178: 231-4(1964). (In German)

The relative transition probabilities for the radiative transitions (nd–1s) and (nd–2p) have been calculated for $\mu$-mesonic atoms. It is found that the intensity of the transition (3d–1s) relative to the transition (3p–1s) is about 4% for Z between 20 and 30. (auth)

**22695** DETERMINATION OF THE PROBABILITY DISTRIBUTION OF THE NUMBER OF SECONDARY ELECTRONS. Z. Bay (National Bureau of Standards, Washington, D. C.) and G. Papp. 9p. (CONF-182-12)

From 9th Scintillation and Semiconductor Counter Symposium, Washington, D. C., Feb. 1964.

It is shown that the probability distribution, p(i), of the release of i slow secondary electrons after the incidence of a primary particle can be determined by the use of a multistage electron multiplier. The EM amplifies to an easily measurable level the effect of the investigated process. First the single electron response of the EM, the pulse height distribution Φ(x) in the output, is experimentally determined. Next the pulse height distribution F(x) is taken when the secondary electrons of the process to be measured enter the input. The moments of the distributions are used in calculating p(i) from Φ(x) and F(x). Thus the successive calculation of the first few moments of p(i) gives information (average, variance, skewness, etc.) of primary interest in many cases. Extension of the calculation to higher moments allows the determination of p(i) via the combinatorial moments. Experimental data taken for an EM with silver-magnesium dynodes show that the secondary emission curve for 230 ev primaries is somewhat broader than a Poisson distribution. (auth)

**22696** MEASUREMENTS OF THE EFFECTIVE POLARIZABILITIES OF THE METASTABLE ($^3P_2$) RARE GASES IN SELECTED MAGNETIC SUBSTATES. E. Robinson, J. Levine, and B. Bederson. 6p. (CONF-481-51)

From American Physical Society Annual Meeting, New York, Jan. 1964.

The polarizabilities of the metastable $^3P_2$ rare gases were measured by the atomic beam, E-H Gradient Balance Method. The data, which are tabulated, show that the effective polarizability of the (1) state exceeds that of the (2) state, and the average polarizabilities exceed those of the ground-state by 16 through 30 times, verifying that an overwhelming proportion of $\bar{\alpha}$ comes from the valence electron. The average polarizabilities tend to increase with increasing atomic number. (P.C.H.)

## Cosmic Radiation

**22697** (AFOSR-5282) TECHNICAL FINAL REPORT [ON COSMIC RAY INTERACTIONS], JULY 1, 1962–JUNE 30, 1963. (Sydney. Univ. School of Physics). 13p. (AD-417493)

High-energy nuclear interaction studies were made using a 20 litre block of nuclear emulsion, an array of 64 large plastic scintillators, 600 G.M. counters and four Wilson Cloud Chambers in Sydney, Australia and two Wilson Cloud Chambers on Sulphur Mountain, Alberta, Canada. The interaction mean free path of protons at 3000 Bev was measured, and the angular distribution of charged particles in nuclear events at 3000 Bev was shown to be in disagreement with predictions of "equilibrium theories" of meson production. Also, the mean multiplicity of mesons in N-N interactions was measured, and the cosmic ray proton energy spectrum was determined to $10^{16}$ ev. The distributions of electrons and high energy nucleons in the cores of extensive air showers were measured, and the electron density spectra of air showers at sea level and at mountain altitude were obtained up to very high densities. A method of recording extensive air showers was also devised. (auth)

**22698** THE SPECTRUM OF VERY HEAVY NUCLEI IN COSMIC RADIATION AND THE PASSAGE THROUGH INTERSTELLAR MATTER. K. Kristiansson (Univ. of Lund, Sweden). Arkiv Fysik, 25: 513-30(1964).

With the assumption that iron is the only very heavy element in the cosmic ray source, calculations were performed of charge spectra of the nuclei in the interval $21 \leq Z \leq 26$ as a function of the amount of interstellar matter traversed and of the mean energy in the collisions between the VH particles and the interstellar nuclei. The comparison with the experimental cosmic ray spectrum shows that the particles have passed through 2-4 g matter at energies below about 500 Mev/nucleon. The amount of matter which has been passed at high energy is smaller. This distribution involves some restrictions on the mechanism of acceleration. (auth)

**22699** COMPARISON OF THE TOTAL COSMIC RADIATION IN DEEP SPACE AND AT THE EARTH DURING THE MARCH-APRIL 1960 EVENTS. Roger L. Arnoldy, John R. Winckler, and Robert A. Hoffman (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 69: 1679-90(May 1, 1964).

A study is made of the intensity of the total radiation in the interplanetary medium before and after the March 28 to April 9, 1960, solar proton events and the March 31, 1960, Forbush decrease as Pioneer 5 moved to a distance of 0.07 AU from the earth. By means of regression plots the space probe ion chamber is compared with a group of neutron monitors and with balloon ion chambers. The comparison covers an energy range from several Bev down to 25 Mev. It is found that the ion chamber rates in the period April 10 to April 26, 1960, return within approximately 1 per cent to the same regression line observed during the period March 11-28 established before the large solar injection of particles. Thus an upper limit for a possible permanent change in the flux of interplanetary radiation greater than 25 Mev caused by these solar events may be derived using the ion chamber absolute calibration for alternative choice of energies as follows: 5 protons/$m^2$ sec ster having energies 25-100 Mev, 10 protons/$m^2$ sec ster having energies 100-250 Mev, or 20 protons/$m^2$ sec ster having energies 250-1000 Mev. Simpson et al. reported a permanent 10 per cent reduction in the interplanetary radiation between 75 Mev and several Bev also measured aboard Pioneer 5 during the same events. Very special assumptions about spectral changes are necessary to reconcile these two measurements. (auth)

**22700** ON THE ZENITHAL DISTRIBUTION OF EXTREMELY-HIGH-ENERGY COSMIC-RAY MUONS IN THE ATMOSPHERE. Kaichi Maeda (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 69: 1725-36 (May 1, 1964).

The approximate calculation of intensities of high-energy cosmic muons at sea level given by Smith and Duller is improved by a rigorous calculation for larger zenith angles and higher energies, starting from the integral formula instead of the so-called diffusion equation of cosmic mesons in the atmosphere. Similar computations are done to show the contribution of kaons; the results are compared with those of Zatseptin and Kuz'min, who used a different attenuation mean free path. The largest difference between the contributions of pions and kaons appears for muon energies of 100-1000 Bev, as Zatseptin and Kuz'min pointed out. It is shown that measurements of obliquely incident high-energy muons are helpful in determining the energy dependence of the attenuation mean free path of charged mesons in the atmosphere rather than to distinguish the muon parent particles. To resolve the arguments regarding the additional source of high-energy cosmic muons, it is proposed that these observations be extended to mountain altitudes. (auth)

**22701** COSMIC-RAY CUTOFFS AT HIGH LATITUDE. Ernest C. Ray (Cornell Univ., Ithaca, N. Y.). J. Geophys. Res., 69: 1737-41(May 1, 1964).

The measurements of many spectrums of solar protons at northern latitudes showed that the cutoffs are commonly

much lower than those calculated for the geomagnetic field as deduced from surface measurements, together with any reasonable ring current. It is shown that most of the observations can be reasonably accounted for with a magnetic field which, in addition to the contributions mentioned, has a turbulent component everywhere beyond a certain distance from the center of the earth. The model is essentially that explored by Parker and by Rothwell. The fact that the solar wind distorts the field at great distances must, as Akasofu et al. suggested, produce a modification, the nature of which is probably the one that began at 1257 UT on this date. (auth)

**22702** THE SCATTERING OF CHARGED PARTICLES BY MAGNETIC IRREGULARITIES. E. N. Parker (Univ. of Chicago). J. Geophys. Res., 69: 1755-8(May 1, 1964).

The equations of motion of a charged particle are integrated through an irregularity in a large-scale magnetic field. The scattering of the particle is shown to diminish as the cyclotron radius of the particle becomes either large or small compared to the scale of the irregularity and to have a maximum when the radius is comparable to the scale. When the cyclotron radius is large, the order of magnitude of the scattering depends on the number of sequential reverse bends in the lines of force through the magnetic irregularity. It is important for the understanding of modulation of the cosmic-ray intensity by the solar wind to determine the degree of correlation between adjacent bends in the irregularities in the interplanetary magnetic field. (auth)

**22703** CHANGE OF COSMIC-RAY INTENSITY WITH DISTANCE FROM THE SUN. H. V. Neher and H. R. Anderson (California Inst. of Tech., Pasadena). J. Geophys. Res., 69: 1911-13(May 1, 1964).

The variation of cosmic ray intensity with distance from the sun is calculated from data taken from Mariner 2 and monitors at the earth. It is shown that cosmic ray intensity was less at the orbit of Venus than at the earth. The gradient found was (12 ± 4)% per AU. (C.E.S.)

**22704** EVOLUTION OF COSMIC RAYS IN GALAXIES. Ko Aizu (Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 31: 83-92(Jan. 1964).

The relative intensity of cosmic ray sources in external galaxies of different types is estimated from the relative frequency of supernovae. The cosmic ray energy in normal galaxies is estimated from radio astronomical data. It is found that the intensity and the lifetime of cosmic rays in spiral galaxies are nearly constant during the spiral evolutional stage. (auth)

## Criticality Studies

*Refer also to abstracts 22175, 22401, 22650, 22728, 22817, 22848, 23026, 23064, and 23139.*

**22705** (HW-80020(p.38-48)) AN APPROXIMATE BUCKLING OF PARTIALLY FILLED SPHERES AND APPLICATION TO CRITICAL EXPERIMENTS. W. A. Reardon (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Buckling measurements are frequently made with spheres that are critical and not full or subcritical while full. A method for determining the critical, full-sphere equivalents for such measurements is presented. Reflected systems are considered, and some results of applications of the method to critical experiments are included. (D.C.W.)

**22706** CRITICALITY IN TRANSPORT THEORY. Hans Hejtmanek. Atomkernenergie, 9: 101-6(Mar.-Apr. 1964). (In German)

The concept of criticality of a slab is simple to describe from physics, but there is no unique mathematical definition. Two methods are described for computing the critical dimensions of a slab by solving the transport equation. The agreement is good for small values of c. (auth)

## Direct Energy Conversion

**22707** (AD-420962) THERMIONIC CONVERTER RESEARCH. Final Report No. 8, July 1, 1962 through June 30, 1963. W. E. Beyermann, R. A. Laubenstein, and J. B. Merzenich (Marquardt Corp., Van Nuys, Calif.). July 1963. Contract DA36-039-sc-87217. 129p. (N63-22918)

Arc-mode converter operation and the performance of solid ion-emitters were investigated for application to low-temperature thermionic converters which can produce reasonable power densities at temperatures compatible with combustion heat sources. Iridium was found to be the best emitter material investigated. A converter with an iridium emitter produced 4.5 w/cm$^2$ at 1377°C emitter temperature, and a converter with a rhenium emitter produced 4.5 w/cm$^2$ at 1405°C. Converters with molybdenum emitters were found to have an initial power output which depends on the contamination in the system, and during the first few days of operation, the power output degrades to a stable value. The operation of a converter with a Philips "B" emitter was found to be strongly influenced by an auxiliary discharge between the emitter or emitter support and a passive auxiliary electrode. Power output with the auxiliary discharge was higher, and the current-voltage characteristic did not display the usual arc-mode transition. Effects of variation in emitter temperature, collector temperature, cesium-reservoir temperature, and interelectrode spacing on power output and on ignition potential were studied. The use of solid ion-dispensers to provide positive ions for space-charge neutralization in a thermionic converter does not appear to be promising with the present state of the art. The two major problems are the efficient use of the ions to neutralize electron space charge and the limited lifetime of the ion-dispenser material. (auth)

**22708** (AERE-R-4590) ELECTRICAL EFFECTS ASSOCIATED WITH THE EMISSION OF FISSION FRAGMENTS FROM A CONDUCTOR. P. J. Silver and G. N. Walton (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1964. 1p.

Two cells consisting of sealed silica envelopes exhausted at about $2 \times 10^{-6}$ mm Hg and containing two concentric stainless steel electrodes were irradiated in a reactor. On the outer electrode of one cell, and facing the inner electrode, was a $U_3O_8$ film. Currents and voltages across the electrodes were measured during the reactor power cycle. Currents were also measured with a voltage applied to the electrodes. The results show that the high positive voltage that might be induced by the passage of high energy, positively charged fission fragments is completely masked by what appears to be the flow of electrons at low voltages. Specific observations are discussed. (D.C.W.)

**22709** (LAMS-3041) COMMENTS ON A STEADY-STATE PLASMA ACCELERATOR. T. F. Stratton, J. Todd, and C. V. Weaver (Los Alamos Scientific Lab., N. Mex.). Dec. 1, 1963. Contract W-7405-eng-36. 46p.

It was predicted that a directed exhaust velocity ~$10^6$ cm/sec could be expected in a coaxial accelerator 60 cm long, with plasma current densities of 10 amp/cm$^2$. A cesium-vapor coaxial-geometry accelerator, supplied with only thermal energy, was built. Exhaust velocities greater

than thermal speed and correlated with electromagnetic acceleration were not observed. Prediction and experiment disagreed because (1) required current densities could not be achieved in the selected geometry, and (2) viscous drag, neglected in the prediction, was the dominating force on the plasma flow. (M.J.T.)

**22710** (NP-13881) RESEARCH ON NEW CONCEPTS IN ENERGY CONVERSION. Quarterly Technical Progress Report No. 2, December 1, 1963–February 29, 1964. William D. Jackson, George A. Brown, Jack L. Kerrebrock, and E. N. Carabateas (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Mar. 1964. Contract AF33(615)-1083. 21p.

Research progress on MHD power generation with liquid metals, thermionic conversion, liquid metal MHD generators is summarized. In connection with thermionic conversion, cesium gas and adsorbed cesium films were studied. (D.C.W.)

**22711** (RTD-TDR-63-4132) LARGE-SIGNAL BEHAVIOR OF A PARAMETRIC MAGNETOGASDYNAMIC GENERATOR. Arthur T. Lewis (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Sept. 1963. Contract AF33(616)-7624. 104p.

The large-signal behavior of a parametric magnetogasdynamic generator consisting of a cylindrical coil with batches of highly conducting plasma traveling along the coil axis was analyzed to determine: whether the requirements for the conductivity and velocity of the gas that are found for small-signal behavior are relaxed because of enhancing mechanism during the interaction; what fraction of the gas power could be extracted as useful electrical power, that is, the overall generator efficiency; how the interaction between the field and the gas leads to gas behavior that limits the growth of the parametric oscillations so that a stable operating point is reached; an estimate of the minimum size and power of a generator with present technology; and the factors that control the scaling of the parametric generator. An analysis is presented for the small-signal behavior to establish the important parameters and provide a basis of comparison for the large-signal behavior. The large-signal electrical and gaseous behavior are treated separately as far as possible. A criterion is established for determining the steady-state operating point in terms of the electrical terminal behavior. The gas-flow interaction with the field is analyzed by using a quasi one-dimensional-flow model with the constraints for a strong interaction that the magnetic pressure balance the static gas pressure in the radial direction and that the power given up by the gas balance the gross electrical power generated. (auth)

**22712** USE OF NUCLEAR ENERGY FOR THE PRODUCTION OF ELECTRICITY BY ELECTROCHEMICAL CONVERSION. P. Vignet (Centre d'Etudes Nucleaires, Saclay, France). Energie Nucl., 6: 3-17(Jan.-Feb. 1964). (In French)

Chemical and radiation sources of energy for direct conversion systems are compared, together with the performance of different direct conversion systems. The properties of energy storage systems are also summarized, as are those of some existing or developmental source-generator systems. The electrochemical processes by which chemical systems and compounds decomposed by heat or radiation can be regenerated with production of energy are then reviewed, and conversion systems using these techniques are compared with other direct conversion techniques. (D.C.W.)

**22713** VISCOSITY OF PARTIALLY IONIZED GASEOUS CESIUM. C. A. Robinson, and I. R. McNab (International Research and Development Co., Newcastle-upon-Tyne, Eng.). J. Appl. Phys., 35: 1742-5(June 1964).

The Chapman–Enskog solution of the Boltzmann equation is used to obtain theoretical data for the viscosity of gaseous cesium, including the effects of up to 10% ionization. Results are presented for the viscosity of ionized cesium at pressures of $10^{-2}$, $10^{-3}$, $10^{-4}$, and $10^{-5}$ atm in the temperature range 1000–3500°K, and for unionized cesium over the same range. The viscosity of the 10% ionized gas is found to be about 20% lower than that of unionized cesium under the same conditions. (auth)

**22714** SUCCESSFUL EXPERIMENTS IN CLOSED CYCLE MAGNETOPLASMADYNAMICS. Nucl. Eng., 9: 177-8(May 1964).

Closed-cycle MPD systems development at International Research and Development Labs. at Newcastle, England are discussed. A test loop is described. (R.E.U.)

**22715** CARBIDE RESEARCH AS RELATED TO THERMIONIC EMISSION. A. F. Weinberg, L. Yang, and R. G. Hudson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.73-95 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964.

Physicochemical properties of mixed carbides of uranium and zirconium were studied in relation to their use as thermionic cathode materials or as the nuclear fuel for refractory-metal thermionic emitters or a combination of both. Temperature and time behaviors were studied. (R.E.U.)

**22716** THERMIONIC RADIATOR SYSTEM. Keith E. Buck (Aerojet-General Nucleonics, San Ramon, Calif.). p.535-49 of "Power Systems for Space Flight." New York, Academic Press, 1963.

Current plans for high power level space power systems are based on the use of high-temperature, liquid-metal cooled reactors coupled to a Rankine cycle power conversion system. An alternate approach is the thermionic radiator concept in which similar reactors are used to supply thermal energy to the cathodes of radiator-mounted thermionic converters. The thermionic radiator system could be a backup to dynamic conversions systems if the liquid-metal-cooled reactors under development are designed to satisfy the requirements of both systems. The thermionic radiator system should be considered also as the prime conversion system. A program to determine the feasibility of a thermionic radiator system is described. The primary objective of the first phase was to demonstrate the operation of a thermionic converter, using a liquid metal to supply thermal energy to the cathode. In addition, some limited systems analysis was performed. The first phase just recently was completed, and the objectives were fully attained. (auth)

## Elementary Particles and Radiations

**22717** (CONF-481-39) LIMIT FOR THE ELECTRON-PROTON CHARGE DIFFERENCE FROM A VAPOR EFFLUX EXPERIMENT. Jens C. Zorn (Michigan. Univ., Ann Arbor. Harrison M. Randall Lab. of Physics). Jan. 1964. Contract AT(11-1)-1112. 29p.

From American Physical Society Annual Meeting, New York, Jan. 1964.

The net charge of a group of un-ionized molecules can be determined by removing them from one electrode of a capacitor and measuring the resultant voltage change across the capacitor. Earlier experiments of this type used the

efflux of a compressed gas; measurements using the efflux of vapors from a liquid or sublimating solid are reported here. The results from measurements on chloroform are interpreted to mean that the electron-proton charge difference is less than $9 \times 10^{-19}$ of the electron charge. A general discussion and comparison of the efflux, droplet, and atomic beam charge equality experiments are given. (auth)

**22718** (DESY-64/2) ON A CLASSICAL STATISTICAL MODEL WITH THE NON-RELATIVISTIC INTEGRALS OF MOTION. H. Joos and H. Satz (Deutsches Elektronen-Synchrotron, Hamburg). Feb. 1964. 17p.

The classical, non-relativistic, phase space integral for fixed energy, momentum, angular momentum, and center-of-mass is evaluated for large particle numbers by means of the central limit theorem of statistics. The problem is treated covariantly with respect to all transformations of the Galilei group. (auth)

**22719** (ISS-63/47) CINEMATICA DELLA DIFFUSIONE ELASTICA DI ELETTRONI DA $\alpha$ TRA 300 E 1500 Mev. (Kinematics of Elastic Scattering of Electrons from $\alpha$ Particles, for Initial Energies from 300 to 1500 Mev). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Dec. 28, 1963. 46p.

Kinematical tables of the elastic scattering of electrons from $\alpha$ particles were calculated for bombarding energies between 300 and 1500 Mev. The calculation was made using a Fortran program (in press) for the IBM 7040 computer. (auth)

**22720** (ISS-64/1) CALCOLO DELLO SPETTRO IN ENERGIA DEI PROTONI DI RINCULO OTTENUTI NELLO SCATTERING ELASTICO n-p. (Calculation of the Proton-Recoil Spectrum in n-p Elastic Scattering). M. Grandolfo (Italy. Istituto Superiore di Sanità, Rome). Feb. 7, 1964. 33p.

A general analytical expression for the proton recoil spectrum in n-p elastic scattering was obtained. A program was devised for calculating the spectrum with the IBM 610 computer. As an example, the recoil spectrum was evaluated for neutron energies of 10, 90, and 400 Mev. An analytical expression was found for the differential cross sections at those energies as a polynomial approximation by the least square method. (auth)

**22721** (JINR-E-1591) ON RELATIVISTIC ANGULAR MOMENTUM THEORY. [PART] I. P. Vinternitts, Ya. A. Smorodinskii, and M. Uglirzh (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 10p.

Explicit relations are given for the components of the relativistic angular momentum in four coordinate systems in the Lobachevsky space of relativistic velocities. Complete sets of commuting operators determining these systems are considered. (auth)

**22722** (JINR-P-1586) IZUCHENIE $\Lambda K^+$ I $K^0K^-$ PAR, ROZHDENNYKH V $\pi^-p$ VZAIMODEISTVIYAKH PRI 7,5 Gev/s. (A Study of $\Lambda K^+$ and $K^0K^-$ Pairs Produced in $\pi^-p$ Interactions at 7.5 Gev/c). V. A. Belyakov, N. M. Viryasov, E. N. Kladnitskaya, V. N. Penev, E. S. Sokolova, and M. I. Solovyev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 16p.

The production of $\Lambda$-$K^+$ and $K^0$-$K^-$ pairs in $\pi^-$-p interactions at 7.5 Gev/c was studied. The center-of-mass angular and momentum distributions of the strange particles are presented. The effective mass distributions for $\Lambda$-$K^+$ and $K^0$-$K^-$ pairs are discussed. The $K^0$-$K^-$ mass distribution shows a resonance peak at 1060 Mev and $\Gamma/2 = 30$ Mev; for $\Lambda$-$K^+$ pairs, no peaking was observed. (auth)

**22723** (JINR-P-1592) O SVYAZI MEZHDU MULYTIPERIFERICHESKIM I BETESOLYPITEROVSKIM PODKHODAMI PRI ISSLEDOVANII FERMIONNYKH POLYUSOV REDZHE. (On the Connection Between the Multiperipheral and Bethe-Salpeter Approaches to the Problem of Fermion Regge Poles). Ya. Kvetsinyski (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 6p.

The problem of fermion Regge poles is investigated using the Bethe-Salpeter equation. It is shown that there exists a splitting of Regge trajectories due to parity. This result is compared with predictions of the multiperipheral model, and complete equivalence of the two approaches is proved. (auth)

**22724** (JINR-P-1596) NARUSHENNYE SIMMETRII PRI VYSOKIKH ENERGIYAKH. (Broken Symmetries at High Energies). V. I. Ogievetskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 5p.

The asymptotic relations for the octuplet-octuplet scattering amplitudes were obtained under the assumption that the effective interaction is a mixture of the unitary singlet and the 3-3 component of the octuplet. (auth)

**22725** (JINR-P-1597) OTSENKA SECHENIYA PEREZARYADKI $\pi^-$-MEZONOV NA KVAZISVOBODNYKH PROTONAKH PRI 9 Gev. (An Estimation of the Cross Sections for 9 Gev $\pi^-$-Meson Charge Exchange on Quasifree Protons). I. M. Gramenitskii, L. S. Okhrimenko, B. Slovinskii, and Z. S. Strugalyskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 8p.

The interaction $\pi^- - p \rightarrow \pi^0 + n$ at 9 Bev was studied in a xenon bubble chamber. An estimate of the cross section was obtained. (D.C.W.)

**22726** (NEVIS-121) ELECTRON DECAY BRANCHING RATIO OF THE PION (thesis). Alan Strelzoff (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Mar. 1964. Contract Nonr-266(72). 62p. (CU-227; R-419)

The ratio of the pion decay rates for the processes, $\pi \rightarrow e + \nu$ and $\pi \rightarrow \mu + \nu$, was measured. A large NaI(Tl) crystal was used to separate the high energy pion decay electrons from the continuous spectrum of the $\pi$-$\mu$-e chain. Counting decay electrons immediately following a pion stop, the ratio was determined by a direct comparison of $\pi$-e and $\pi$-$\mu$-e electrons. From an observed 10,891 $\pi$-e electrons a precision of 1.8% was attained in the quantity (pion lifetime × branching ratio). Considering the present uncertainty in the pion lifetime the branching ratio, $(1.247 \pm 0.028) \times 10^{-4}$ is obtained. This is in good agreement with the theoretical value, $1.233 \times 10^{-4}$, required by the V-A theory when radiative corrections are included. (auth)

**22727** (NP-13860) PHYSIQUE DES MESONS $\pi$ DE BASSE ENERGIE. (Physics of $\pi$ Mesons at Low Energy). Roland Omnes (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). [1961]. 128p.

The main characteristics of mesons ($\pi$) and the methods by which they were determined are summarized. Isotopic spin and quantum field theory are then considered, and $\pi$-N scattering at low energies is analyzed. Theory for $\pi$-N scattering at low energies in the static model is reviewed, together with Mandelstam representation. (D.C.W.)

**22728** (NP-13870) REPORT ON RECENT EXPERIMENTAL DATA, 1963. Matscience Report 17. K. Venkatesan (Institute of Mathematical Sciences, Madras). 11p.

Data from the 1963 monthly reports (since April) on strong, weak, and electromagnetic interactions are compiled. Experiments on the third sound in liquid helium film

and on the energy gap in superconductors are also reported. The data include interaction, resonance production, and particle production cross sections; nucleon form factors; particle and resonance properties; $\pi$-p phase shifts; and meson($\mu^-$) capture rates. (D.C.W.)

**22729** (NP-13871) LECTURES ON THE MANDELSTAM REPRESENTATION. Matscience Report 6. I. LECTURES ON DISPERSION THEORY. T. K. Radha. II. LECTURES ON THE STRIP APPROXIMATION. K. Venkatesan (Institute of Mathematical Sciences, Madras). [1963]. 147p.

An abstract approach to the theory of strong interactions is utilized and the mathematical implications are studied. General principles such as Lorentz invariance, causality, and unitarity deduced from field theory are used in proving dispersions relations by establishing analyticity properties of matrix elements. Relations between experimentally measurable quantities and the matrix elements are obtained. Spectral representation for scattering amplitudes in the fourth order perturbation theory is studied, and the fourth order Feynman diagram is expressed in the form of the Mandelstam representation. The strip approximation is defined and is explained in terms of Cuthoshy diagrams. Application to the problem of photoproduction of a pion from a nucleon is discussed, giving details of the calculations. The consequences of the strip approximation are studied for photoproduction in $\pi$-$\pi$ and $\pi$-N scattering. (L.B.S.)

**22730** (NP-13877) THEORY OF WEAK INTERACTIONS OF ELEMENTARY PARTICLES. Matscience Report 10. R. E. Marshak (Institute of Mathematical Sciences, Madras). 1963. 177p.

The interactions and properties of elementary particles are reviewed, and weak interactions are considered in relation to the different invariance principles. The universal theory of weak interaction is then outlined; and purely leptonic processes, strangeness-conserving leptonic weak processes, strangeness violating leptonic decays, and nonleptonic decays of strange particles are treated. (D.C.W.)

**22731** (NP-13880) LECTURES ON AN INTRODUCTION TO COMPLEX ANGULAR MOMENTUM, REGGE POLES, AND HIGH-ENERGY SCATTERING. Matscience Report 8. K. Raman (Institute of Mathematical Sciences, Madras). [1963]. 175p.

A series of twelve lecturers on Regge poles and their role in high-energy diffraction scattering is presented. The basic concepts are surveyed, together with the experimental observations from which they arise. 50 references. (D.C.W.)

**22732** (NP-13890) RELATIVISTIC DIRECT INTERACTION THEORIES (thesis). Technical Report No. 322. R. Fong (Maryland. Univ., College Park). July 1963. Contract AFOSR-62-361. 98p.

Direct interaction theories are examined from the viewpoint of relativistic scattering heory and the associated concept of asymptotic covariance. It is pointed out that with any two-particle hamiltonian that has no bound states there can be associated a variety of representations of the Lie algebra of the inhomogeneous Lorentz group (IHLG). It is shown that the requirement of asymptotic covariance ensures both the covariance of the S-matrix and the existence of a unique representation of the IHLG to be associated with a relativistic two-particle system. The connection between the Lie algebra, the covariant form of the S-matrix, and the uniqueness of K, the generator of pure Lorentz transformations, is thereby clarified. The extension of these considerations to include bound states and production processes is made. The two-particle form of H given by Bakamjian and Thomas is shown to satisfy asymptotic covariance and, moreover, to be the most general form of interest from the viewpoint of relativistic scattering theory, thereby including as a special case a form of H suggested by Sudarshan. It is also proved that relativistic hamiltonians of this type do not admit the usual notion of a coupling constant. The problem of three particles is considered and a difficulty with the three-particle form of H indicated by Bakamjian and Thomas is exhibited. (auth)

**22733** (NP-13896) NRL QUARTERLY ON NUCLEAR SCIENCE AND TECHNOLOGY. Progress Report for the Period July–September 1963. (Naval Research Lab., Washington, D. C.). Oct. 1, 1963. 70p.

Separate abstracts were prepared for six sections of the report. One other section, on the Lee model and the meson ($\rho$), was previously abstracted in NSA 18: 18681. (D.C.W.)

*For abstracts of individual sections see: 22588, 22589, 22590, 22591, 22734, and 22735.*

**22734** (NP-13896(p.1-14)) EXTENSION OF THE FERMI-YANG MODEL. D. W. Joseph (Naval Research Lab., Washington, D. C.).

Fermi and Yang proposed a model for the meson ($\pi$) consisting of a bound N-$\bar{N}$ pair. The model is extended to include spin-1 mesons and to allow for the possibility of an interaction that is not entirely of the vector form originally assumed. (D.C.W.)

**22735** (NP-13896(p.35-50)) ONE-DIMENSIONAL ELECTRON BEAM MODEL: EQUILIBRIUM OF SMALL SYSTEMS. Gary Herling (Naval Research Lab., Washington, D. C.).

The Vlasov and N-particle approaches to equilibrium of one-dimensional electron beam systems are discussed, together with the case of a zero temperature plasma. Maxwell-Boltzmann equilibrium is then considered; and an approximation to it, a sectionally homogeneous phase density equilibrium, is examined. (D.C.W.)

**22736** (UCB-64-2) A SEARCH FOR QUARKS. M. di Corato, W. B. Fretter, H. J. Lubatti, and W. Michael (California. Univ., Berkeley). Apr. 7, 1964. 8p.

Gell-Mann recently introduced a unitary triplet of fractionally charged particles that allow for the mathematical construction of baryon octets without the necessity of assuming a basic baryon singlet. The members (quarks) of the triplet are assumed to have $J = \frac{1}{2}$, $B = \frac{1}{3}$, and charge $z, z+1$, where $z = -\frac{1}{3}$. An unsuccessful attempt was made to observe quarks produced by proton interactions with nuclei at 23.4 Bev in a propane-freon bubble chamber. An upper limit on the total cross section of 5.5 $\mu$b with an 87% confidence limit was established for the production of quarks of mass < 2.4 Bev and lifetime > $10^{-10}$ sec. (D.C.W.)

**22737** THRESHOLD LAWS FOR PROCESSES OF AUTOIONIZATION. J. D. Morrison (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Chem. Phys., 40: 2488-92(May 1, 1964).

New data obtained by photon and electron impact was examined in an attempt to determine more accurately the threshold laws for processes of autoionization. In the cases of Kr and Xe, it was found that marked interference can occur between the two competing processes of direct and autoionization. The results, and also some of the apparently anomalous ionization efficiency data obtained by electron impact for several of the metals, can be interpreted in terms of configuration-interaction phenomena involving excited states of very short lifetimes. (auth)

**22738** DETERMINATION OF THE RELATIVISTIC MOTION EQUATION OF AN ELECTRICALLY CHARGED PARTICLE POSSESSING SPIN AND MAGNETIC MOMENT BY MEANS OF THE VARIATION METHOD. Jeno Solyom. Magy. Fiz. Folyoirat, 11: 489-99(1963). (In Hungarian)

Several authors have examined previously the relativistic motion of an electrically charged particle, such as an electron, possessing spin and electric moment. The original study of J. Frenkel (Z. f. Phys., 37: 243(1926)) which made use of the variation method, was further developed by J. Horvath, deriving the motion equation of the electron. A more recent work by K. Nagy, based on the Infeld method, yielded different values. In order to obtain the correct motion equation by the variation method, the Lagrange function was improved by introducing a modifying term. The same term was also used to examine the kinematic energy-pulse tensor. The actual value of the Lagrange multiplier could not be determined directly. (TTT)

**22739** DETERMINATION OF SCATTERING AMPLITUDES FOR UNSTABLE PARTICLES AT ZERO ENERGY FROM THE ANALYSIS ON REACTIONS WITH THREE PARTICLE PRODUCTION NEAR THE THRESHOLD. Julia Nyiri. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 43-56(1964). (In Hungarian)

A dispersion method developed by A. A. Anselm and V. N. Gribov for calculating amplitudes and cross sections for reactions with three-particle production near the threshold is described and used in the cases $\pi^+ + p \rightarrow \pi + \pi + N$, $\pi^+ + p \rightarrow K^+ + \Lambda^0 + \pi^+$, and $\pi^+ + p \rightarrow K + \Sigma + \pi$. Cross sections with respect to the momenta of the particles produced are obtained with an accuracy to third order terms for the first reaction and linear for the other two. Comparing the respective formulas with experimental data, it is possible to determine the scattering amplitudes of unstable particles. (auth)

**22740** A BINDING ENERGY CALCULATION FOR TRITON USING A VELOCITY DEPENDENT POTENTIAL. T. R. Heywood (Southampton Univ., Eng.). Phys. Letters, 9: 170-1(Apr. 1, 1964).

Results of variational calculations of the binding energy for tritons using the potential by Werner and wave functions by Cohen and Willis yield a value of −7.66 Mev. It is pointed out that better agreement with the experimental value, −8.48 Mev, can be obtained by varying further the values of the variational parameters. (L.B.S.)

**22741** PROTON-ANTIPROTON INTERACTIONS AT 3.6 Gev/c AND ONE PION EXCHANGE. H. C. Dehne (Physikalisches Staatsinstitut, Hamburg), E. Raubold, P. Soeding, M. W. Teucher, and G. Wolf, and E. Lohrmann. Phys. Letters, 9: 185-7(Apr. 1, 1964).

Elastic, inelastic, and total cross sections for pion production in proton-antiproton interactions at 3.6 Bev/c were found. The $p\bar{p} \rightarrow p\bar{p}\pi^0$, $p\bar{p} \rightarrow p\bar{n}\pi^-$, and $p\bar{p} \rightarrow p\bar{p}\pi^+\pi^-$ reactions were studied in detail and were compared with the one pion exchange model using the form factors of Ferrari and Selleri. Quantitative agreement with statistics was found for the details of the reactions and for the absolute value of the cross sections. (L.B.S.)

**22742** ON THE PROPERTIES OF B RESONANCE. V. M. Shekhter (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Letters, 9: 187-9(Apr. 1, 1964).

Spin, parity, and other properties of B resonances are investigated. An experiment is proposed which allows $J^P = 0^-$ to be distinguished from $J \geq 1$. The question of the place of the B resonance in unitary symmetry is also discussed. (L.B.S.)

**22743** ρ−EXCHANGE MECHANISM FOR THE REACTION $\pi^+p \rightarrow \omega N^{*++}$. V. Barger and E. McCliment (Univ. of Wisconsin, Madison). Phys. Letters, 9: 191-4(Apr. 1, 1964). (TID-20386)

The $\omega N^{*++}$ production process is examined by the ρ exchange model. Angular distributions of the decay pion are found to be independent of the momentum transfer form factors at vertices where the ρ is emitted and absorbed. The differential cross sections for $\pi N^{*++}$ production are obtained in terms of the total cross section for $\pi^0$ photoproduction and are compared with experimental data of $\omega N^*$ production at three different energies. The dependence of the production angular distribution on the momentum transfer is noted. (L.B.S.)

**22744** BETHE-SALPETER EQUATION WITH A NONPLANAR KERNEL. A. P. Contogouris (Center for Advanced Study in Physics, Athens). Phys. Letters, 9: 194-7(Apr. 1, 1964).

It is shown that Regge poles as well as a Gribov-Pomeranchuck singularity are associated with a nonplanar Bethe-Salpeter kernel. (L.B.S.)

**22745** THE REACTION $\pi + d \rightleftharpoons p + p$ IN IMPULSE APPROXIMATION. H. G. Dosch (Universitat, Heidelberg). Phys. Letters, 9: 197-9(Apr. 1, 1964).

The results of calculations of total and differential cross sections for the $\pi^+ + d \rightarrow p + p$ reaction are tabulated and are compared with experimental values. Calculated values for different types of π-N phase shifts are compared, and best results were found for the Fermi I type. (L.B.S.)

**22746** EXPERIMENTAL LIMIT ON THE PRODUCTION BY 24 Gev PROTONS OF LONG-LIVED PARTICLES WITH FRACTIONAL ELECTRIC CHARGE. D. R. O. Morrison (CERN, Geneva). Phys. Letters, 9: 199-200(Apr. 1, 1964).

It is deduced from experimental observations and assumptions on the momentum distribution and production angle that the production cross section for particles with mass less than 2.4 Bev by 24-Bev protons is less than $10^{-33}$ cm$^2$. (L.B.S.)

**22747** AN UNSUCCESSFUL SEARCH FOR FRACTIONALLY CHARGED PARTICLES WITH MASS $\lesssim$ 2.2 Gev. H. H. Bingham (CERN, Geneva), M. Dickinson, R. Diebold, W. Koch, D. W. G. Leith, M. Nikolic, B. Ronne, R. Huson, P. Musset, and J. J. Veillet. Phys. Letters, 9: 201-3 (Apr. 1, 1964).

A rough estimate of the upper limit for the total cross section for production of charge $\frac{1}{3}$ e and $\frac{2}{3}$ e particles in copper-proton collisions was obtained. It is concluded from an unsuccessful search that if particles of charge $0.2 \lesssim q/e \lesssim 0.7$ are produced in pairs in proton-copper collisions with cross sections similar to other strongly interacting particles, they must have a mass above ~2.2 Bev or lifetime less than $\lesssim 10^{-7}$ sec. (L.B.S.)

**22748** A POSSIBLE HIGHER SYMMETRY SCHEME FOR STRONGLY INTERACTING PARTICLES. H. J. Lipkin (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 9: 203-4(Apr. 1, 1964).

The "barbaryon" classification of strongly interacting particles, which places particles having the same isospin and hypercharge into multiplets whose states are characterized by the values of the ordinary spin and baryon number, is proposed. Other possible classification schemes are presented. (L.B.S.)

**22749** A STUDY OF THE $K^- P\pi^+\pi^-$ STATE PRODUCED BY K⁻−P AT 1.5 Gev/c. S. P. Almeida and G. R. Lynch (CERN, Geneva). Phys. Letters, 9: 204-6(Apr. 1, 1964).

A systematic analysis of the reaction $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ was made, and 101 events of this type were studied in search for the K* (730-Mev) resonance. It is concluded that 35 percent of the $K^- p \rightarrow K^- p\pi^+ \pi^-$ events at 1.45 Bev/c proceed via $Y_0^*$ (1520) production. No strong presence of the kappa meson was observed. (L.B.S.)

**22750** EVIDENCE FOR A (Kππ) RESONANCE WITH A MASS OF 1.230 Gev/$c^2$. R. Armenteros (CERN, Geneva), D. N. Edwards, T. Jacobsen, et al. Phys. Letters, 9: 207-9(Apr. 1, 1964).

Two- and three-particle effective mass combinations in the final state of $\bar{p} + p \rightarrow K_1^0 + K_1^0 + \pi^+ + \pi^-$ were studied, and results show a pronounced enhancement of the $(K_1^0\pi^+\pi^-)$ distribution near 1.230 Bev/$c^2$. Dalitz plots of the (Kππ) system are presented, and the decay of this resonance is studied. (L.B.S.)

**22751** MASS FORMULAE FOR THE MESON, BARYON, AND ISOBAR STATES IN SCHWINGER'S GROUP, $W_3$. Elizabeth Johnson and R. F. Sawyer (Univ. of Wisconsin, Madison). Phys. Letters, 9: 212-14(Apr. 1, 1964).

Mass relations for the 18 multiplet in Schwinger's $W_3$ group are derived. Some modifications of Schwinger's approach to baryon mass differences are proposed. (L.B.S.)

**22752** QUASI-ELEMENTARY MASSLESS BOSONS ASSOCIATED WITH THE QUANTUM ELECTRODYNAMICS OF JOHNSON, BAKER AND WILLEY. Y. Nambu (Univ. of Chicago). Phys. Letters, 9: 214-16(Apr. 1, 1964).

The problem of massless bosons resulting from the spontaneous breakdown of invariances is considered. It is argued that they exist and are coupled to the electron with strength comparable to the electromagnetic coupling. Some properties are examined. (L.B.S.)

**22753** SCATTERING OF ENERGY-TIME WAVE PACKETS FROM MANY-BODY SYSTEMS. L. R. Dodd (Univ. of Adelaide) and I. E. McCarthy. Phys. Rev., 134: A1136-42 (June 1, 1964).

The wave-packet nature of an experimental beam is discussed. The theory of wave-packet scattering is applied to wave packets with exponential time dependence scattered from resonances in both the isolated-resonance and overlapping-resonance regions. It is shown how a sequential description of scattering depends on some of the resonance parameters in the scattering amplitude. The meaning and usefulness of some experimentally possible wave-packet experiments is discussed. (auth)

**22754** POSITRONIUM IN A LiH CRYSTAL. S. M. Neamtan and R. I. Verrall (Univ. of Manitoba, Winnipeg, Can.). Phys. Rev., 134: A1254-60(June 1, 1964).

The question as to whether the existence of a bound positronium-like system in an ionic crystal is energetically possible is considered with particular reference to lithium hydride. The crystal field of LiH is simulated by a potential expressed as a sum of central field potentials centered on the ion sites. An upper bound is obtained for the ground-state energy of a system of an electron and a positron in Coulomb interaction with each other and moving in the crystal potential, and comparison is made with estimates of the energies of the positron and the electron moving independently in the crystal. The result is energetically favorable to the formation and persistence of positronium in the crystal through capture by a positron of an electron from the valence band. (auth)

**22755** EFFECT OF STRONG ABSORPTION IN PARTICLE EXCHANGE REACTIONS. A. Dar and W. Tobacman (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Letters, 12: 511-13(May 4, 1964).

It is proposed that, when elastic distortion is present, the one-particle exchange amplitude vanishes for low partial waves and is real for high partial waves. It is shown that this model seems especially appropriate with strong absorption and leads to simple transition-amplitude expressions. Analysis suggests that strong-absorption distribution effects may be included in transition-amplitude calculations with first-order perturbation theory using plane waves by simply dropping the low angular momentum partial-wave contributions. The suggestion is illustrated by considering the amplitude for scalar-meson exchange. (M.J.T.)

**22756** PION-PION INTERACTION AND THE $K_{e4}$ DECAY. Laurie M. Brown and Harry Faier (Northwestern Univ., Evanston, Ill.). Phys. Rev. Letters, 12: 514-17(May 4, 1964).

The $K_{e4}$ decay processes, $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$ and $K^+ \rightarrow \pi^0 + \pi^0 + e^+ + \nu$, are studied. It is assumed that the decay is mediated by a scalar, isospin-zero resonance, the $\sigma$ meson. It is shown that a single dimensionless weak axial vector coupling constant $g_A \approx 1.5 \times 10^{-7}$ determines the rate of both $K_{e4}$ and $K_{\mu 3}$ decays, predicting a ratio of the rates which agrees with experiment. (M.J.T.)

**22757** COMPILATION OF RESULTS ON THE TWO-PION DECAY OF THE ω. G. Luetjens and J. Steinberger (Columbia Univ., New York). Phys. Rev. Letters, 12: 517-21(May 4, 1964).

A correlation of data on the decay $\omega^0 \rightarrow \pi^+ + \pi^-$ is made. Reactions considered are $\pi^\pm + p \rightarrow \pi^\pm + p + (\omega^0)$, $K^- + p \rightarrow \Lambda^0 + (\omega)$, and $\pi^- + p \rightarrow n + (\omega^0)$, among others. It is found that there is no statistically significant indication for the decay of $\omega^0$ into 2 pions, for all the available data. (M.J.T.)

**22758** SELECTION RULE FOR BOSONS. J. B. Bronzan and F. E. Low (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 12: 522-3(May 4, 1964).

It is pointed out that evidence on boson decays is consistent with an empirical selection rule, A invariance, which is compatible with, but does not require, unitary symmetry. Several possibilities for the A quantum number's relation to baryons are considered. The application of A invariance to individual bosons is discussed. Some further electromagnetic-property predictions are stated. (M.J.T.)

**22759** UNITARY SYMMETRY AND ELECTROMAGNETIC SELF-ENERGIES OF NEUTRAL VECTOR MESONS. Paul Singer (Columbia Univ., New York). Phys. Rev. Letters, 12: 524-6(May 4, 1964).

It has been postulated that the nine known vector mesons—ρ, ω, K*, and φ—belong to a degenerate nonet. Here it is shown, by calculating contributions to self-energies, that a large amount of the mass difference $m_\omega - m_\rho$ is of electromagnetic origin. Unitary symmetry and information from measured electromagnetic ω decays are used. (M.J.T.)

**22760** OBSERVATION OF A NONSTRANGE MESON OF MASS 959 Mev. George R. Kalbfleisch, Luis W. Alvarez, Angela Barbaro-Galtier, et al. (Univ. of California, Berkeley). Phys. Rev. Letters, 12: 527-30 (May 4, 1964).

The hydrogen bubble chamber was exposed to a beam of $K^-$ mesons. Reactions considered are $K^- + p \rightarrow \Lambda^0 + (0,1)$ MM + $(0,1,2,3)(\pi^+ + \pi^-) + (0,1)\pi^0$, where "MM" represents "missing mass." MM is found to be a meson of mass 959 ± 2 Mev, full width $\Gamma \lesssim 12$ Mev, and isospin T = 0 or 1, decaying into $\pi^+ + \pi^- + \eta$. (M.J.T.)

**22761** SELF-CONSISTENCY OF SUPERGLOBAL MULTIPLET ASSIGNMENTS. R. E. Cutkosky (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. Letters, 12: 530-1(May 4, 1964).

It is shown that the assignment of the $^3/_2^+$ meson-baryon resonances to $(3 \cdot 6)$, where $(R_1 \cdot R_2)$ denotes an irreducible representation in Schwinger's SU(3) × SU(3) superglobal symmetry model and $R_1$ and $R_2$ are SU(3) representations, is incompatible with simple dynamical arguments. (M.J.T.)

**22762** ELECTRON CYCLOTRON MASER. J. L. Hirshfield and J. M. Wachtel (Yale Univ., New Haven). Phys. Rev. Letters, 12: 533-6(May 11, 1964).

The experimental observation of maser action in a system of relativistic electrons in a d-c magnetic field is reported. The magnetic field difference from cyclotron resonance is observed as a function of absorption coefficient and electron energy and is compared to theory. (M.J.T.)

**22763** AN UPPER BOUND ON THE NEUTRON-DEUTERON $^2$S SCATTERING LENGTH. L. M. Delves, J. N. Lyness, and J. M. Blatt (Univ. of New South Wales, Sydney and New York Univ., New York). Phys. Rev. Letters, 12: 542-4(May 11, 1964).

Zero-energy n-d scattering data lead to quadratic equations for the doublet and quartet scattering lengths; the data do not indicate which of two sets of solutions is correct. A scattering function is derived, taking into consideration hard cores, exchange symmetry, spin-orbit forces, and the upper-bound requirement. Realistic 2-body potentials—Brueckner-Gammel, Hamada-Johnston, and Yale—are investigated with this function. Each case produces an upper bound that allows only the smaller of the two sets of solutions for the doublet scattering length. (M.J.T.)

**22764** FURTHER RESULTS ON THE BINDING ENERGY OF THE TRITON. J. M. Blatt and L. M. Delves (New York Univ., New York and Univ. of New South Wales, Sydney). Phys. Rev. Letters, 12: 544-6(May 11, 1964).

The triton binding energy is investigated for the Brueckner-Gammel, Hamada-Johnston, and Yale potentials using three new trial wave functions. Some improvement is obtained. (M.J.T.)

**22765** EXISTENCE OF A NEW MESON OF MASS 960 Mev. M. Goldberg (Syracuse Univ., N. Y.), M. Gundzik, S. Lichtman, et al. Phys. Rev. Letters, 12: 546-50(May 11, 1964).

Three reaction channels—$K^- + p \rightarrow \Lambda$ + neutrals, $K^- + p \rightarrow \Lambda + 2\pi^+ + 2\pi^- + \pi^0$, and $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ + (neutrals with mass > m .)—exhibit 960-Mev peaks in $M^2$ spectra. These peaks, along with the mass subspectra snd peripheral nature of the 960-Mev events in the third channel, establish the existence of a new meson, the $X^0$. The $X^0$ meson has mass 960 ± 5 Mev, $\Gamma > 20$ Mev, strangeness 0, and isospin 0 or 1. (M.J.T.)

**22766** WEAK CURRENTS AND BROKEN UNITARY SYMMETRY. Reinhard Oehme (Univ. of Chicago and CERN, Geneva). Phys. Rev. Letters, 12: 550-2(May 11, 1964).

The relative strengths of the strangeness-changing and -nonchanging currents which enter into the weak interaction are computed. Only mesonic matrix elements are considered. There is some indication that the rotated orientation of the weak current in unitary space may be due to the same symmetry-breaking interaction responsible for meson-octet mass splitting. (M.J.T.)

**22767** THE PHYSICS OF HIGH-ENERGY AND ELEMENTARY PARTICLES AT THE WARSAW CENTER AT HOZEJ. Marian Danysz and Jerzy Pniewski (Warsaw Univ. and Inst. for Nuclear Research, Warsaw). Postepy Fiz., 14: 633-7(1963). (In Polish)

Studies at the Warsaw Center at Hozej are discussed. The Center was organized soon after World War II, and work in high-energy physics and elementary particles was initiated in about 1947. In 1952 a block of nuclear emulsion exposed in the stratosphere was received from Bristol. In this block the production and decay of a hyperon ($\Lambda^0$) was observed. Later work, which was done on emulsions irradiated with mesons ($K^-$), centered on the tasks of measuring the mass and energy spectrum of the $\Lambda^0$ particle. At present, the work in high-energy physics deals with hypernucleons, and the fragmentation of nuclei and the interaction of high-energy particles with nuclei. The elementary particle investigations are concerned with the properties of elementary particles and resonance states, and high-energy interactions in the case of simple structure. Work is in progress with nuclear emulsions, bubble chambers, and spark chambers. (TTT)

**22768** POSSIBLE EXISTENCE OF A SUPER-Ω. H. Hoegasen (Norges Tekniske Hogskole, Trondheim, Norway). Proc. Phys. Seminar Trondheim, No. 3, 3p.(1964).

The existence of an Ω particle with I = 0, Y = −4 at ~2190 Mev is proposed. (C.E.S.)

**22769** THE INTERACTIONS OF 1.13 Gev/c $K^-$-MESONS WITH NUCLEON PAIRS. L. Culhane, A. Kerman, J. Losty, and A. Montwill. Proc. Roy. Irish Acad., A63: 61-7(Jan. 1964).

A study of 254 inelastic interactions of $K^-$ mesons at 1.13 Bev/c produced evidence for $K^-$ interactions with correlated nucleon pairs. The relative frequency of such two-nucleon processes is comparable to that for $K^-$ absorption at rest in heavy nuclei. (auth)

**22770** AN APPROACH TO THE NON-LEPTONIC DECAYS OF HYPERONS. Ziro Maki and Masami Nakagawa (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 31: 115-25(Jan. 1964).

The relation between the effective weak interaction and the hyperon structure is discussed with the aim of explaining non-leptonic decays of hyperons. A consistent model is found by assuming that Σ- and Λ-hyperons are bound states of $[\bar{K}N]$ with I = 1 and 0, respectively, and that the effective Hamiltonian is given solely by the phenomenological kaon interactions, $K \rightarrow \pi$, $2\pi$, with $|\Delta I| = 1/2$. This model leads naturally to the consequences $\alpha_\Sigma^0 \simeq -\alpha_\Lambda^-$ and $\alpha_\Sigma^+ \simeq \alpha_\Sigma^- \simeq 0$, which are consistent with the experiments. Derivation of this model from the field theory of composite particles is given by the covariant new Tamm-Dancoff approach. The theory being extended to the Ξ decay, it is suggested that the Ξ-hyperon is a superposed state of the configurations $[\bar{K}\Sigma]$ and $[\bar{K}\Lambda]$. The co-existence of D- and F-type strong interactions defined by $SU_3$-symmetric theory is shown to be necessary by comparing the p-wave transition rates of Σ-decay with that of Λ. (auth)

**22771** BOSON AND BARYON SCATTERING IN THE VIOLATED OCTET MODEL. Masataka Hosoda (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 31: 126-38(Jan. 1964).

In the framework of the unitary symmetry scheme, the stabilities of the irreducible representations of the baryon-boson systems are considered for cases both of the symmetry limit and of broken symmetry, using the static approximation. The one-dimensional and ten-dimensional representations seem to be most stable. Their levels are identified with the resonant levels of $Y_0^*$, $N_{\frac{1}{2}}^*$, $Y_1^*$, and $\Xi_{\frac{1}{2}}^*$, by adjusting $\alpha$, $\beta$, and A, the D coupling-interaction and

F coupling-interaction mixing parameters and the cut-off energy, respectively. The mass of the I = 0 member of the ten-dimensional multiplets is predicted. Furthermore, the coupling constants among baryons and bosons and an explanation of the small branching ratio of $Y_1^*$ are obtained from these parameters. (auth)

**22772** ON THE PROCESSES WITH $\Delta Q/\Delta S = -1$. Hiroshi Segawa (Fukui Univ., Japan). Progr. Theoret. Phys. (Kyoto), 31: 151-2(Jan. 1964).

A previous model explaining $K^0$ decay where $\Delta Q/\Delta S = -1$ and postulating a new $\pi_2$ meson is altered. Assumptions concerning charges are changed in order to explain $\Sigma$ and $K_{\ell 4}^+$ decays. In the modified model $\pi_2$ does not decay to the ordinary $\pi_1$ and plays no role in weak processes. (M.J.T.)

**22773** DISTRIBUTION OF FOUR-MOMENTUM TRANSFER IN MULTIPLE MESON PRODUCTIONS BY HIGH ENERGY MUONS. S. Higashi (Osaka City Univ.), T. Kitamura, Y. Mishima, S. Miyamoto, H. Shibata, Y. Watase, K. Daiyasu, K. Kobayakawa, T. Murota, and T. Nakano. Progr. Theoret. Phys. (Kyoto), 31: 154-7(Jan. 1964).

Multiple $\pi$-meson production by underground cosmic-ray muons was observed in large cloud chambers. It was estimated that the incident muon energies are in the range 10 to a few hundred Bev. Multiple meson production with high 4-dimensional momentum transfer is discussed. Integral spectra of incident-muon deflection angles and of 4-momentum transfers are plotted for experimental and theoretical values. (M.J.T.)

**22774** TWO NEUTRINOS, PARITY NONCONSERVATION AND SELECTION RULES OF THE WEAK INTERACTION AMONG LEPTONS. Kanji Fujii and Hideaki Nagai (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 31: 157-8(Jan. 1964).

The existence of 2 kinds of neutrinos necessitates a reconsideration of weak interactions and nonconservation of parity. Isotopic K space, where $e^-$, $\nu_e$ and $\mu^-$, $\nu_\mu$ are doublet, is introduced. A result for weak-interaction selection rules, similar to that obtained in c-number theory, is achieved by simultaneously taking into account leptonic weak-interaction symmetry in K space and the Y-A-coupling type in the Lorentz space. (M.J.T.)

**22775** A NOTE ON SYMMETRIES OF THE WEAK INTERACTIONS. Kanji Fujii and Hideaki Nagai (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 31: 159-61(Jan. 1964).

An attempt is made to generalize a previous explanation of the connection between c-number theory and weak-interaction selection rules for baryon and baryon-lepton interactions. The connection does not seem so probable in the latter case as in the former. (M.J.T.)

**22776** THE MASS OF MUONIC NEUTRINO. Tan Lu, Kuo-shen Yang, and Leau-fu Lo. Wu Li Hsueh Pao, 20: 19-32(Jan. 1964). (In Chinese)

The rest-mass effects of the muon neutrino are discussed. The influence on the two processes—the radiative decay of $\pi$ mesons and the muon-electron annihilation—in which these effects are exhibited appreciably is analysed in detail. It is shown that no conflict with existing experimental data would arise from assuming the muonic neutrino to possess a finite, not too small rest-mass. Observations for a more accurate evaluation of the rest-mass of the muonic neutrino are also suggested. (auth)

**22777** CHERENKOV EMISSION OF CHARGED PARTICLES WITH ORIENTED SPIN. Ch'en-fa Lu. Wu Li Hsueh Pao, 20: 97-103(Feb. 1964). (In Chinese)

A quantum electrodynamic method was used for determining the influence of spin on the intensity and polarization of Cherenkov emission by charged particles moving in a dielectric. In the case of transversely polarized particles the emission intensity has a new quantum supplement. Similarity, for longitudinally polarized particles the emission consists of two parts: polarized and nonpolarized. (R.V.J.)

**22778** LOW-ENERGY PION-NUCLEON SCATTERING. Hong Guan (Peking Univ.). Wu Li Hsueh Pao, 20: 207-15(Mar. 1964). (In Chinese)

The fixed angle dispersion relations near the forward direction are applied to the derivation of the integral equations of s- and p-wave pion-nucleon scattering amplitudes. The equations involve the contribution of annihilation process, in which the main contribution comes from the two pion intermediate state. In order to examine the effect of $\pi\pi$ interaction on pion-nucleon scattering, the observed values of scattering phase shifts are substituted into the equations, and the numerical calculation is given. Using the experimental informations of the form factors of the electromagnetic structure of the nucleon, and taking the square resonance energy $t_r = 20$, the $I = J = 1$ $\pi\pi$ scattering resonance width parameter $\gamma = 0.1$ is obtained. This result is consistent with the experimental data of all three low angular momentum partial wave amplitudes, but the resonance width is small compared with the observed value. (auth)

**22779** THE SECOND RESONANCE IN $\pi$–N ELASTIC SCATTERING. Shih-chun Chang (Peking Univ.). Wu Li Hsueh Pao, 20: 216-26(Mar. 1964). (In Chinese)

The extended Chew-Low equation for $\pi$–N scattering under the two pion approximation is solved by neglecting contribution from the crossing terms. From rapidly increasing pion production cross section the elastic scattering cross section of the $D_{3_2}$ channel ($T = \frac{1}{2}$) was calculated. The peak of elastic scattering cross section in the second resonance is explained. (auth)

**22780** UNSTABLE PARTICLES IN THE PERTURBATION THEORY. J. J. Henning (National Research Inst. for Mathematical Sciences, Pretoria, South Africa and Council for Scientific and Industrial Research, Pretoria, South Africa). Z. Physik, 177: 227-39(1964). (In German)

Modifications of the analyticity properties of Feynman diagrams (in particular, the so-called "substitution law") due to the presence in the internal lines of propagators of unstable particles, are investigated. The discussion is restricted to the one and two particle structures (i.e. those characterized by poles or branchpoints induced by one or two internal lines respectively when one of the latter is a propagator of an unstable particle). The existence of unstable particles is indicated to be consistent with a canonical model; a detailed discussion is not included. The model is perturbation-theoretic; non-observables are treated only after suitable modifications to the Dyson prescriptions have been made. Before the relation between the singularities (poles, branchpoints) induced by internal lines corresponding to unstable particles and the masses associated with such internal lines can be appreciated, the analogous relation in terms of stable particles is made completely explicit. The one-particle structure realized when the internal line is due to an unstable particle is studied. In this case the scattering amplitude has, in terms of the energy-variable for that line, a cut from $(2m)^2$ to $\infty$ (where 2m is the sum of the masses of the stable decay products), and also has an analytic continuation through this cut with a pole at $M^2 - i\gamma$ in the second sheet, where M denotes the observed mass of the unstable parti-

cle and $\gamma$ is proportional to the inverse life-time of the unstable particle. The two-particle structure realized when one internal line is due to an unstable particle of mass M and the other to a stable particle of mass $m_{s,r} = m$ is studied. The unstable particle can decay into two stable particles each of mass $m_{s,r} = m$. The arguments indicate that the scattering amplitude has a cut, in terms of the energy-variable for the channel from $(3m)^2$ to $\infty$ as well as an analytic continuation through the cut into the lower half plane. In the second Riemann sheet there exist branch-points at $(\sqrt{M^2 \pm i\gamma} \pm m)^2$ and at infinity. (auth)

**22781** EXACT SOLUTION OF LOW EQUATIONS. J. Rothleitner (Universität, Heidelberg). Z. Physik, 177: 287-99(1964). (In German)

The general solution of the Low equation for a family of two-dimensional crossing-matrices is constructed. It depends on 2 arbitrary functions and its Riemann surface has an infinity of distinct sheets. Furthermore a subclass of solutions of the 3 dimensional and 4 dimensional pseudoscalar symmetric $\pi$-N scattering theory is constructed, the former depending on 2 arbitrary functions and the latter on 3. The criterion of minimal zeros in the scattering functions on the physical sheet is applied, to restrict this manyfold. In the three-dimensional case the restricted solution depends on 2 parameters which may be interpreted as "coupling constant" and "cutoff." In the 4 dimensional case the criterion of minimal zeros in the scattering functions gives a solution which depends on 5 parameters and thus is not uniquely determined by a "coupling constant" and "cutoff." (auth)

**22782** A SPECULATION OF THE "MESON RESONANCES." J. S. Levinger (Cornell Univ., Ithaca, N. Y.). 22p. (CONF-481-53)

From American Physical Society Annual Meeting, New York, Jan. 1964.

The meson resonances are interpreted in an extended Fermi-Yang and Sakata model as bound states of $N\bar{N}$, $N\bar{\Lambda}$, or $\Lambda\bar{\Lambda}$. The four S states of $N\bar{N}$ are interpreted as the $\pi$, $\eta$, $\rho$, and $\omega$. The f at 1250 Mev and the B (or $\pi + \omega$) at 1220 Mev are interpreted as $^3P_2$ isoscalar and $^1P_1$ isovector respectively. The positions and decay modes of other P states are estimated: the $^3P_2$ isovector may lie near 1200 Mev, and would decay principally into $\pi + \eta$. The vector $\phi$ is interpreted as $\Lambda\bar{\Lambda}$ in a $^3S_1$ state. The corresponding $^1S_0$ would be a pseudoscalar resonance, and may lie near 700 Mev. The 725 Mev $K^0$ does not fit into this model, so confirmation of its existence would be still another crucial experiment. (auth)

## Field Theory and Quantum Mechanics

**22783** (NP-13797) THE KINETIC EQUATION OF CLASSICAL BOLTZMANN GASES. Fluid Mechanics Laboratory Publication No. 64-2. C. H. Su (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). Mar. 1964. Contract Nonr-1841(93). 29p.

By use of the multiple-time-scale method, the low density expansion is carried to the order of the triple collision integral. The validity of Bogoliubov's assumption that the multiple distribution depends functionally on a single particle distribution is carefully examined. It is found that such an assumption is valid except locally for those particles that have a large separation at a time t and have their relative velocity so oriented that they were in collision at t = 0. Since this local breakdown is very selective. the triple collision integral which is found in the literature is still correct. As a by-product of the multiple-time-scale method, the rate at which a system approaches the kinetic state is obtained; it is also found that up to the order considered the Maxwellian distribution is the only solution at thermal equilibrium. (auth)

**22784** (NP-13879) LECTURES ON FOUNDATIONS OF QUANTUM MECHANICS AND QUANTUM FIELD THEORY (SUMMER 1962). Matscience Report 11. E. C. G. Sudarshan (Institute of Mathematical Sciences, Madras). 115p.

Concepts and formulations of quantum mechanics and field theory are reviewed and examined. (D.C.W.)

**22785** (NP-13882) MAGNETIC SUSCEPTIBILITY OF ELECTRONS IN A SIMPLE BLOCH BAND. Technical Report No. 3. G. H. Wannier and U. N. Upadhyaya (Oregon. Univ., Eugene). [1962]. Contract NONR-2771(05). 47p.

The magnetic susceptibility arising from electrons in a simple Bloch band is re-derived using the uncoupled field-dependent bands developed previously. Gauge and phase invariance proofs are given; and the contributions of the Landau-Peierls diamagnetism, crystalline paramagnetism, and induced diamagnetism to the susceptibility are obtained. (D.C.W.)

**22786** (NP-13893) QUASI-PARTICLE LIFETIMES BY GREEN'S FUNCTION METHOD. Technical Report No. 186. QUANTUM THEORY OF DOMAIN-WALL MOTION. Technical Report No. 187. James F. Janak (Massachusetts Inst. of Tech., Cambridge. Lab. for Insulation Research). Mar. 1964. Contract Nonr-1841(10). 30p.

The application of the Green's function method to the calculation of the response of systems of Bose particles to external fields and to the calculation of the energies and lifetimes of the quantum states of the system is reviewed in order to furnish mathematical preliminaries for the quantum theory of domain-wall motion. The response of a ferromagnetic spin system to external magnetic fields is considered. A description of the problem of domain-wall motion is presented, and the domain-wall damping parameter is calculated in terms of fundamental quantities. (C.E.S.)

**22787** (TID-20515) THE WIGNER REPRESENTATION AND APPLICATIONS TO SCATTERING THEORY. M. Rosenbaum and P. F. Zweifel (Michigan. Univ., Ann Arbor). [1962]. Contract [AT(11-1)-917]. 64p.

A simplified development of the Weyl-Wigner formulation of quantum statistical mechanics is presented. The Weyl-Wigner method is used to express density fluctuations in quasi-classical systems in a power series in $\hbar$. The various terms in the expansion can be calculated from classical mechanics, assuming only that the interparticle (central) potentials are known. (D.C.W.)

**22788** IDENTICAL MOTION IN QUANTUM AND CLASSICAL MECHANICS. Nathan Rosen (Univ. of North Carolina, Chapel Hill). Am. J. Phys., 32: 377-9(May 1964).

The conditions are set down, under which the stationary-state motion of a particle in a static field of force is the same according to the Schroedinger equation as in classical mechanics. Some solutions are found. All the cases obtained correspond to unbound states. (auth)

**22789** DYNAMICS AND ELECTROMAGNETIC RADIATION OF A CHARGED AND COHERENT FLUID. Francis Fer (Faculte des Sciences, Rennes, France). Compt. Rend. 258: 2983-98(Mar. 16, 1964). (In French)

Theory for the dynamics and radiation of the electron (on a classical basis) is noted to require consideration of

the electron as a charged fluid, not a rigid body, and inclusion of cohesive forces as well as internal electromagnetic forces. The fluid motion, continuity, and energy equations are given. (D.C.W.)

**22790** ION OPTICS OF FIELDS WITH ROTATIONAL SYMMETRY AND CIRCULAR MAIN ORBIT. A. J. H. Boerboom (FOM-Laboratory for Mass Separation, Amsterdam). J. Appl. Phys., 35: 1691-7(June 1964).

By means of a symmetry property of the ion orbits in magnetic or electric fields with rotational symmetry, the ion optics inside these fields can be simply deduced. The physical meaning of the various terms in the expressions for the ion orbits is clarified. First-order imaging properties are derived. The calculations on the ion optics of fields with an axis and a plane of symmetry are generalized by omitting the requirement of the symmetry plane. The trajectories in the field are calculated up to the second order. The general equation of the ion path is given. The first-order imaging properties are discussed. The method is extended to calculate the ion paths up to the second order in instruments having one or more fields with a plane and an axis of symmetry. By introducing the concept of optical aberrations in the object, the calculation of higher-order aberrations can be simplified to a large extent. (auth)

**22791** FURTHER DEVELOPMENT OF THE CONFIGURATION INTERACTION METHOD BY USING THE SPIN-OPERATOR PROCESS. Ferenc Berencz (Jozsef Attila Univ., Szeged). Magy. Fiz. Folyoirat, 11: 479-88 (1963). (In Hungarian)

In view of the fact that an exact solution of the wave equation is possible only in a few special cases of the potential function, approximation methods must be used for solving quantum mechanical problems. The eigenfunction satisfies the Pauli principle if it is antisymmetric in all of the electron coordinates. This condition is fulfilled if the molecular function is represented in the form of a Slater determinant; the latter corresponds to a configuration as it indicates the distribution of the electrons to shells with certain spin functions. In the configuration interaction method, the zero-order eigenfunction of a system consisting of n electrons is given by the linear combination of a series of specific Slater determinants. In view of the mathematical difficulties involved in the solution, the configuration interaction method was further developed, making use of the spin-operator scheme. Calculations carried out in the case of the benzene molecule indicated that the thus developed spin-operator scheme and the Slater-Pauling method are equivalent. (TTT)

**22792** TIME REVERSAL IN QUANTUM MECHANICS. Péter Hraskó. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 57-84(1964). (In Hungarian)

Time reversal characteristics are discussed from a uniform point of view with particular regard to applications in nuclear physics. (auth)

**22793** GRAVITATIONAL COLLAPSE. H. Bondi (London Univ.). Nature, 202: 275(Apr. 18, 1964).

On the problem of gravitational collapse, reference has repeatedly been made to the nucleonic mass of a body as an integral involving the density and pressure of the material. Modern work has followed earlier results on the supposed particle number integral for a spherically symmetric configuration, according to general relativity. It is pointed out that the integral used is wrong and also that no such integral can possibly exist. It is stated that the original misunderstanding is probably due to the notion that, although general relativity is a continuum theory, an invariant integral related to mass must concern the invariant particle number. (P.C.H.)

**22794** A MODIFIED SOURCE THEORY OF ELECTROMAGNETIC PROPAGATION. L. M. Stephenson (University Coll., London). Nature, 202: 375-6(Apr. 25, 1964).

Relativistic electromagnetic effects are considered, and a modified ballistic source theory of electromagnetic propagation is derived. Doppler frequency shifts that arise because of apparent changes in the propagation velocity and wavelength in this theory are discussed. An attempt is made to relate gravitational forces to negative radiation pressure forces produced by the radiation of electromagnetic energy by atomic particles. (C.E.S.)

**22795** THE EIH EQUATIONS OF MOTION UP TO THE 9TH ORDER. M. Carmeli (Israel Inst. of Tech., Haifa). Phys. Letters, 9: 132-4(Apr. 1, 1964).

A method of obtaining the equations of motion for the two particle cases in which the velocity of the particles are much smaller than the velocity of light is presented. The effect of gravitational radiation is taken into account and the case of circular motion of two equal masses is discussed. (L.B.S.)

**22796** ON A SOLUBLE MODEL OF RELATIVISTIC FIELD THEORY. D. W. Robinson (Univ. of Illinois, Urbana). Phys. Letters, 9: 189-90(Apr. 1, 1964).

The conclusions of an analysis of the conditions imposed by the Jacobi identity on a quantum field theory model are presented. (L.B.S.)

**22797** SINGULAR LOGARITHMIC POTENTIALS IN $g\varphi^4$ THEORY. J. M. Charap (Imperial Coll. of Science and Tech., London) and N. Dombey. Phys. Letters, 9: 210-12 (Apr. 1, 1964).

Various forms of logarithmic potentials are reviewed for singularities in the resulting wave function. (L.B.S.)

**22798** HAMILTONIAN METHODS AND QUANTUM MECHANICS. P. A. M. Dirac (St. John's Coll., Cambridge, Eng.). Proc. Roy. Irish Acad., A63: 49-59(Jan. 1964).

The value of the Lagrange and Hamiltonian formalism in quantum mechanics is discussed. (C.E.S.)

**22799** LOCAL ISOTOPIC GAUGE TRANSFORMATION. Kazuhisa Shima (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 139-50(Jan. 1964).

The theory of the local isotopic gauge transformation is formulated mathematically in such a way that it is founded on the general space-time manifold and is independent of the types of semi-simple Lie groups to be used. The formulation of the local isotopic gauge transformation in terms of the concept of homomorphism between sheaves is added. (auth)

**22800** MONTE CARLO INTEGRATION OF THE SCHRÖDINGER EQUATION. M. H. Kalos (United Nuclear Corp., White Plains, N. Y.). Trans. N. Y. Acad. Sci., 26: 497-504(Feb. 1964).

Energy values of bound states and information about the corresponding eigenfunctions are obtained from Monte Carlo solution of the Schroedinger equation in an effort to shed light on many body forces in nuclei. (R.E.U.)

**22801** AN EXACT SOLUTION FOR UNIFORMLY ACCELERATED PARTICLES IN GENERAL RELATIVITY. W. B. Bonnor and N. S. Swaminarayan (London Univ.). Z. Physik, 177: 240-56(1964).

We present an exact solution of the Einstein empty-space equations referring to four particles in relative motion. The particles move with different uniform accelerations relative to a coordinate system which is Minkowskian at infinity, except in certain directions. If positive and negative masses are allowed, the particles can move freely under their own gravitation; if all four masses are positive, stresses extending to infinity are needed to cause the mo-

tion, but two of the particles can move freely. There are three results of interest. First, the field can be described in terms of a classical potential, which is the average of retarded and advanced potentials corresponding to the particles. Secondly, the field at spatial infinity is entirely different from that of a static mass, and the $g_{ik}$ fall off like the inverse square of the distance. Thirdly, the world-lines of free particles are geodesics of the space-time. (auth)

**22802** UNSTABLE PARTICLES IN THE PERTURBATION THEORY. II. CONVERGENCE CHARACTERISTICS OF THE GEOMETRIC SERIES FOR THE PROPAGATION FUNCTION. J. J. Henning. Z. Physik, 178: 253-67(1964). (In German)

Necessary and sufficient conditions for the convergence of the improper-graph series (damping series) in certain regions of the $p^2$-plane are derived for the cases of both stable and unstable particles. The field-theoretical model underlying the discussion is perturbation-theoretic. Non-observables (in the unstable case) are treated only after suitable modifications of the Dyson-prescriptions have been made. The stable-particle and unstable ($m_{b,r} > 2m_{a,r}$) cases are dealt with. (auth)

**22803** STATISTICAL MECHANICS OF EQUALLY LIKELY QUANTUM SYSTEMS. Norbert Rosenzweig (Argonne National Lab., Ill.). p.91-158 of "Statistical Physics." New York, W. A. Benjamin, Inc., 1963.

The theory of time-reversal and the effect of time-reversal invariance on hamiltonian matrices, ensembles in real-symmetric matrices, and calculations with the Gaussian ensemble are discussed. (R.E.U.)

**22804** STATISTICAL MECHANICS OF CHARGED PARTICLES. R. Balescu. Monographs in Statistical Physics and Thermodynamics. Volume 4. New York, Interscience Publishers, 1963. 489p. $15.00.

A rigorous statistical-mechanical treatment of the fundamental equations of plasma physics is presented. Charged particle assemblies are studied from a unified point of view, regardless of particle origin. Both rigor and unification are made possible by the recent development of a general statistical mechanics of non-equilibrium processes. Classical and quantum-statistical systems are treated separately. (M.J.T.)

## Geophysics

**22805** (AFCRL-63-305) MAGNETIC, TELLURIC CURRENT, AND VLF OBSERVATIONS DURING THE 'FISH BOWL' TESTS OF 1962. Keith B. Mather and Eugene M. Wescott (Alaska. Univ., College. Geophysical Inst.). Jan. 1963. Contract AF19(604)-6180. 47p. (AD-417451)

The high-altitude nuclear explosions over Johnston Island were monitored at Cold Bay and College, Alaska. The test of July 9 was monitored at Oamaru, New Zealand. Some observations were also made at Shepherd Bay, Canada. The observed effects are described, and some of the records are reproduced. Simultaneous telluric observations were made on July 9 at magnetically conjugate stations at Oamaru and Cold Bay. The main characteristic of all telluric observations was an initial rapid oscillation with a period of 2.5 to 3.0 sec, followed by oscillations of longer period. The July 9 test produced a major disturbance with the first disturbance arriving within 1 sec of detonation. The instrumentation is also described. (D.C.W.)

**22806** (LAMS-3059) ENERGY DEPOSITION IN THE ATMOSPHERE BY DELAYED GAMMAS FROM FISSION. E. W. Bennett (Los Alamos Scientific Lab., N. Mex.). Mar. 24, 1964. Contract W-7405-eng-36. 16p.

Calculated source functions are provided for the determination of energy deposition in the atmosphere by delayed gammas from fission of $^{235}U$ and $^{238}U$. The gamma spectra and the source strength for debris resulting from 1 kton of fission yield in each case are included. Calculations are done for both "good" and "bad" geometry. Energy deposition rates are determined from $10^{-2}$ to 20 sec after fission and extrapolated as $t^{-1.2}$ for times >20 sec. (auth)

**22807** (RM-3744-PR) AN ANALYTICALLY SOLVABLE MODEL FOR THE ELECTROMAGNETIC FIELDS PRODUCED BY NUCLEAR EXPLOSIONS. W. Sollfrey (RAND Corp., Santa Monica, Calif.). July 1963. Contract AF-49(638)-700. 19p. (AD-419396)

A model is presented which retains space and time variation of conductivity and current, but can be solved analytically. (D.C.W.)

**22808** THE MORPHOLOGY OF THE ELECTRON DISTRIBUTION IN THE OUTER RADIATION ZONE AND NEAR THE MAGNETOSPHERIC BOUNDARY AS OBSERVED BY EXPLORER 12. John W. Freeman, Jr. (Iowa State Univ., Iowa City). J. Geophys. Res., 69: 1691-1723(May 1, 1964).

The routine survey of the heart of the outer radiation zone as well as the region of transition between the magnetosphere and interplanetary space on the sunward side of the earth by means of a variety of particle and magnetic field detectors is discussed. The data received from the detectors during the entire 112-day lifetime were comprehensively analyzed. Salient features observed include: confirmation of the enhancement of soft electron fluxes and diminution of hard electron fluxes in the outer zone during magnetically disturbed times; the outward motion of the outer zone hard electron maximum during periods of enhancement; confirmation of the general Chapman and Ferraro picture of a well-defined magnetosphere with compression of the geomagnetic field during the initial phases of magnetic storms; the existence of a layer of quasi-thermalized plasma immediately outside the magnetosphere; confirmation of the result of Frank and Van Allen that the contours of constant counting rate for electrons with $E \geq 40$ kev tend to protrude outward near 90° from the subsolar point and draw closer to the earth on the night side; and general support for the result of Gringauz, Kurt, Moroz, and Shklovskii that there exists a region beyond some $8R_e$ on the night side of the earth dominated by very-low-energy electrons. (auth)

**22809** LONGITUDINAL DRIFT VELOCITY OF GEOMAGNETICALLY TRAPPED PARTICLES. L. L. Newkirk and Martin Walt (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 69: 1759-63(May 1, 1964).

Longitudinal drift velocities for charged particles trapped in a realistic representation of the geomagnetic field are calculated for the magnetic shell L = 1.25. It is found that the drift velocity varies with longitude, being as much as 30 per cent greater in the region of magnetic anomalies. The effect of the drift velocity variation on the average atmospheric densities and effective scale heights for trapped particles on this shell is considered. The variation is found to reduce average densities calculated for certain traces of constant (B, L) by 10 to 25 per cent but not to significantly influence calculated values of effective scale heights in the range of altitudes considered. (auth)

**22810** A NEUTRAL-POINT EXPANSION OF THE IDEAL MAGNETOSPHERE. Ronald Blum (Goddard Inst.

for Space Studies, New York). J. Geophys. Res., 69: 1765-8(May 1, 1964).

The idealized model of the geomagnetic field-solar wind interaction yields a singular (neutral) point on the magnetopause at which the magnetic field vanishes. If the fields are expanded in a power series around this point, including quadratic terms, an approximate equation of the magnetopause in a small neighborhood of the neutral point that is consistent with the idealized boundary conditions to fourth order can be derived. The additional pressure due to multiple reflections of particles in this neighborhood is considered, and it is shown that less than a 4 per cent correction to the single-reflection pressure condition is necessary. (auth)

**22811** EFFECT OF OBLIQUE INTERPLANETARY MAGNETIC FIELD ON SHAPE AND BEHAVIOR OF THE MAGNETOSPHERE. G. K. Walters (Rice Univ., Houston, Tex.). J. Geophys. Res., 69: 1769-83(May 1, 1964).

The oblique angle made by the spiral interplanetary magnetic field with the radially expanding solar wind is shown to result in an easterly deflection of the solar wind as it traverses the standing hydromagnetic shock wave a few earth radii upstream of the magnetosphere. A quantitative estimate of the deflection angle can be obtained from the plasma shock relations, which are solved generally to yield the particle density, temperature, magnetic field, and plasma flow field immediately behind the shock front in terms of the corresponding interplanetary (preshock) parameters. For typical values of the interplanetary plasma and magnetic field parameters, the calculated deflection angle lies between 5 and 20°. The earth's orbital velocity relative to the radial solar wind direction contributes approximately an additional 5° deflection. The two effects combined cause the axis of symmetry of the magnetosphere, on the average, to be tilted away from the earth-sun line as if the solar wind came from an apparent direction between 10 and 25° to the west of the sun. These conclusions are consistent with a considerable body of experimental data and also suggest an alternate explanation for Explorer 10's numerous encounters with the magnetospheric boundary. (auth)

**22812** ELECTRICAL PROCESSES IN THE NIGHTTIME EXOSPHERE. R. C. Sagalyn and M. Smiddy (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 69: 1809-23(May 1, 1964).

The results of nighttime measurements of positive ion densities between 240 and 1875 km are presented. The ion scale height is found to change abruptly around 600 km, increasing from 120 at 500 km to 1400 at 640 km; it increases gradually with height above this level. An ion temperature of (1050 ± 50)°K is deduced from the ion scale height measured above the peak of the F region. The ion-density measurements were obtained by means of a spherical electrostatic analyzer. In the altitude region 280 to 350 km the ion-density values agree to within 15 per cent with the electron-density measurements obtained from local ground-based ionosondes. The vertical distributions of the principal light ions above 400 km are calculated, assuming the existence of diffusive equilibrium. The relative abundance of the different ionic species at the reference level is determined from the measured profile of the total ion density. The results of the nighttime flight show that the atomic oxygen ion is the principal constituent below 530 km and ionized hydrogen the major constituent above 550 km. An upper limit is placed on the helium ion distribution, which attains its maximum value at 550 km. At this level it constitutes a maximum of about 7 per cent of the total ion density. The ion-atom interchange coefficient for the production of $NO^+$ is calculated from the variations with time of charge densities in the altitude region 280 to 300 km; the coefficient is found to vary between 2 and $4 \times 10^{-12}$ $cm^3$ $sec^{-1}$. (auth)

**22813** IONIZATION OF $N_2$ IN THE UPPER ATMOSPHERE BY GEOMAGNETICALLY TRAPPED ELECTRONS. J. M. Malville (Univ. of Michigan, Ann Arbor). J. Geophys. Res., 69: 1831-7(May 1, 1964).

Sunlit auroral rays extend to heights in the atmosphere at which the ionization equilibrium of $N_2$ may be dominated by trapped electrons of the outer radiation belt. If and when this occurs, the luminosity profile of the resonance scattering of sunlight by $N_2^+$ in such rays would be determined largely by the pitch-angle distribution of the outer-belt electrons. The estimated luminosity profiles occurring near solar maximum resemble those of observed rays in that the luminosity decreases slowly with height over many atmospheric scale heights. It is suggested that sunlit rays result directly from columnar density fluctuations in the outer belt. Visible rays reaching above 1000 can be produced near solar maximum from the occasional intense fluxes of trapped electrons that were detected. (auth)

**22814** GENERALIZATION AND CRITIQUE OF THE WIND-SHEAR THEORY OF SPORADIC E. David Layzer (Harvard Univ., Cambridge, Mass.). J. Geophys. Res., 69: 1853-60(May 1, 1964).

Previous discussions of the hypothesis that sporadic E layers result from a redistribution of existing ionization caused by vertical ionization drift have rested on special and somewhat unrealistic assumptions. The hypothesis is formulated in a more general way and its implications are compared with recent experimental results concerning the structure of $E_s$ layers and the connection between ionization profiles and wind profiles in the E region. The main results of the paper are: The predicted ionization profiles have cusp-like peaks (rounded off by diffusion) of variable width, the width of a peak being inversely proportional to the square of its height. Theory also predicts a substantial reduction of the electron density on either side of a peak. By contrast, observed ionization profiles have nearly rectangular peaks of uniform width ($\lesssim$1 km) and variable heigth ($1 \leq N_{max}/N_0 \lesssim 10^2$) superimposed on an apparently unperturbed background. Theoretically, layers of enhanced ionization will form in regions where the wind shear is exceptionally high. Observation shows that the reverse is true. The fractional changes that can be produced by vertical ionization drift appear to be considerably smaller than those observed to be associated with $E_s$ layers. A related hypothesis, that layers of enhanced ionization form through the trapping of vertically drifting ionization by narrow turbulent layers, also conflicts with experiment. (auth)

**22815** IONOSPHERIC SCREENING EFFECT AND STORM SUDDEN COMMENCEMENT. Atsuhiro Nishida (Univ. of British Columbia, Vancouver and Univ. of Chicago). J. Geophys. Res., 69: 1861-74(May 1, 1964).

In former estimates of the ionospheric screening effect, a magnetic potential field or an electromagnetic wave was employed to represent the disturbance field in the neutral atmosphere. But characteristics of a number of changes observed in the geomagnetic field are inconsistent with these special field representations. Hence an estimate of the ionospheric modification is repeated, using a more general solution of Maxwell's equations with parameters chosen to fit the observed features. The result shows that the modification of the incident electromagnetic field by

the ionosphere depends not only on the time scale of the phenomenon but also on the mode and the scale in space of the incident field. For changes with a time scale of 10 to 100 seconds and a scale in space of the order of $10^8$ cm, the modification is appreciable on one of the two incident modes. The direction of the magnetic field of this mode significantly rotates during passage through the ionosphere. When this result is applied to the sudden commencement of the magnetic storm it is found that a deformation of the magnetosphere by the viscous force of the corpuscular stream may be responsible for the preceding reverse change of a sudden commencement. (auth)

**22816** SOME OBSERVATIONS AND CHARACTERISTICS OF TYPE Pc 1 GEOMAGNETIC MICROPULSATIONS. H. W. Smith (Univ. of Texas, Austin). J. Geophys. Res., 69: 1875-81(May 1, 1964).

General characteristics of earth currents and geomagnetic micropulsations in the Pc 1 band (0.2- to 5-sec period) based on observations made at three sites are reported. Examples of recent active periods in September-October 1963 indicate relations between orthogonal E and H components. Simultaneous records indicate a time delay in the signal envelopes of 2 to 3 sec. (auth)

**22817** GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 1903-9(May 1, 1964).

Data are presented for the principal geomagnetic storm sudden commencements for the period Oct.-Dec. 1963. Maximum activity and ranges of the storms are presented. Solar activity characteristics are given for Dec. 1963. Planetary magnetic three-hour-range indices for Jan. 1, 1963 through Jan. 13, 1964 are included. (C.E.S.)

**22818** TIME AND LONGITUDINAL DRIFT INTEGRALS FOR PARTICLE MOTIONS IN THE EARTH'S MAGNETIC AND GRAVITATIONAL FIELDS. T. G. Stinchcomb (Illinois Inst. of Tech., Chicago). J. Geophys. Res., 69: 1914-16 (May 1, 1964).

The effects of the gravitational field on the time and longitudinal drift integrals for particles moving slowly along a geomagnetic field line are considered. (C.E.S.)

**22819** LONG-LIVED EFFECTS IN THE D REGION AFTER THE HIGH-ALTITUDE NUCLEAR EXPLOSION OF JULY 9, 1962. A. H. Brady, D. D. Crombie, A. G. Jean, A. C. Murphy, and F. K. Steele (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 1921-4 (May 1, 1964).

It is shown that effects that lasted for at least one week were produced in the high-altitude explosion. The behavior of the phase of v-l-f signals propagating over long paths after the explosion is discussed. It is proposed that the decrease in size of the diurnal variations after July 9 is due principally to a reduction in the effective height of reflection during the night. Such an alteration in the effective height of reflection could be brought about by radiation from radioactive debris suspended above the D region if some of the resulting ionization occurred between the normal daytime and nighttime regions of reflection. (C.E.S.)

**22820** TELEVISION CINEMAPHOTOGRAPHY OF AURORAS AND PRELIMINARY MEASUREMENTS OF AURORAL VELOCITIES. T. N. Davis (Goddard Space Flight Center, Greenbelt, Md.) and G. T. Hicks. J. Geophys. Res., 69: 1931-2(May 1, 1964).

The use of color and black and white television cinemaphotography techniques to provide data for the study of a variety of morphological aspects of auroral structures is discussed. Auroral motions and pulsations and the growth, decay, and configurations of individual structures can be studied. (C.E.S.)

**22821** FURTHER OBSERVATIONS OF THE ZODIACAL LIGHT FROM A HIGH ALTITUDE STATION AND INVESTIGATION OF THE INTERPLANETARY PLASMA. I. INTRODUCTORY SURVEY AND PHOTOELECTRIC MEASUREMENTS OF BRIGHTNESS. D. W. Beggs (The Observatories, Cambridge, Eng.), D. E. Blackwell, D. W. Dewhirst, and R. D. Wolstencroft. Monthly Notices Roy. Astron. Soc., 127: 319-28(1964).

Observational knowledge of the electron density in interplanetary space is briefly reviewed, and the methods used during an expedition to Chacaltaya, Bolivia, outlined. Results of scans of the zodiacal light with a photoelectric photometer made in the course of the investigation are first presented, and a new method used to separate the zodiacal light from the night sky background. The isophotes thus obtained are corrected for the effect of scattering in the Earth's atmosphere to give the true isophotes. (auth)

**22822** FURTHER OBSERVATIONS OF THE ZODIACAL LIGHT FROM A HIGH ALTITUDE STATION AND INVESTIGATION OF THE INTERPLANETARY PLASMA. II. SPECTROPHOTOMETRIC OBSERVATIONS AND THE ELECTRON DENSITY IN INTERPLANETARY SPACE. D. W. Beggs (The Observatories, Cambridge, Eng.), D. E. Blackwell, D. W. Dewhirst, and R. D. Wolstencroft. Monthly Notices Roy. Astron. Soc., 127: 329-40(1964).

A spectrophotometric method is described for separating the contributions to the zodiacal light of scattering by dust, and by free electrons. A suitably designed photoelectric spectrometer was used to compare the intensities of the two Fraunhofer lines H$\beta$ and Fe I 4384 in the spectra of the zodiacal light (with correction for night sky background) and of sunlight. The results are interpreted as indicating an electron density of $16 \pm 20$ cm$^{-3}$ in interplanetary space at 1 A.U. from the sun. (auth)

**22823** AURORAL-ZONE MAGNETIC EVENTS. R. S. Iyengar (Univ. of Maryland, College Park). Nature 202: 372-5(Apr. 25, 1964).

Statistical properties of auroral-zone magnetic events are considered. The discussion is based on an analysis of the magnetic data for a period of two years. (C.E.S.)

**22824** PROPAGATION OF RADIOWAVES AT FREQUENCIES BELOW 300 KC/S. Proceedings of the Seventh Meeting of the AGARD Ionospheric Research Committee, Munich 1962. W. T. Blackband, ed. AGARDograph 74. London, Pergamon Press, 1964. £7.

Thirty-two papers were presented on the lower ionosphere, D-layer irregularities, oblique incidence measurements, radio noise below 300 kc, vlf propagation, elf propagation, and the earth-ionosphere cavity. (R.E.U.)

## Low Temperature Physics

**22825** (AD-272637) NUCLEAR RESONANCE IN LIQUID AND SOLID $He^3$ AT LOW TEMPERATURES. Final Technical Status Report, November 1, 1960—October 31, 1961. J. Hatton and D. F. Brewer (Oxford Univ. Clarendon Lab.). Contract DA-91-591-EUC-1643. 31p.

Nuclear resonance in $He^3$ at very low temperatures and high pressures is to be studied. Cryogenic and electronic equipment was constructed and tested at temperatures of 1 to 3°K. Two electronic systems for NMR measurements were investigated, and the susceptibility of the liquid was measured at a pressure of 50 cm Hg between 2.6 and 1°K. The spin lattice relaxation time was measured to be about

1 min. This very low value was attributed to impurity or wall relaxation. (D.C.W.)

**22826** METASTABLE RESISTANCE STATES IN THE INTERMEDIATE REGION OF SUPERCONDUCTORS. Bogoljub Lalevic (Franklin Inst., Philadelphia). J. Appl. Phys., 35: 1785-9(June 1964).

Resistance fluctuation studies in the current-induced intermediate state are extended to the intermediate state induced by the application of an external magnetic field. Evidence for the existence of resistance levels is again found for both directions of the superconducting transition. The resistance levels are interpreted in terms of superconducting domains. The number of levels consequently represents the number of superconducting domains present and the difference $\Delta R$ between the two successive resistance levels correspond to a spread of the normal phase over a length $\Delta l$ of a specimen. The transition time between two successive resistance levels is identified as the time of collapse of a domain. The observed transition times for soft superconductors are compared with the theory of propagation of a normal phase boundary, and some conclusions on the structure of the intermediate state are presented. (auth)

**22827** CALCULATION OF THE CURRENT AND FIELD DISTRIBUTION AND THE MAGNETIZATION CURVES FOR HIGH-FIELD, SUPERCONDUCTING MATERIALS IN THE FORM OF SHEET. H. Riemersma (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 35: 1802-6(June 1964).

The field and current distribution in a high-field, superconducting material in sheet form, where the applied magnetic field is parallel to the sheet is determined. The distributions are obtained from a critical state equation and Maxwell's equations, and determined for the two cases of absence or presence of a net transport current in the material. The field distributions are used to determine the magnetization of the material as a function of applied magnetic field, with the short-sample current-carrying capacity as a parameter. The zero transport current magnetization curves show good agreement in general shape with those experimentally observed. The analysis indicates a reduction in magnetization with increasing transport current. (auth)

**22828** SURFACE CURRENTS IN TYPE II SUPERCONDUCTORS. S. Gygax (Swiss Federal Inst. of Tech., Zurich) and R. H. Kropschot. Phys. Letters, 9: 91(Apr. 1, 1964).

The resistive transition of a copper plated In–6% Pb alloy rod was measured, and the results were compared with unplated samples. The value obtained was $H_{c3} = 1.15\, H_{c2}$. (L.B.S.)

**22829** PARAMAGNETIC RELAXATION IN $CeCl_3 \cdot 7H_2O$ SINGLE CRYSTALS AT HELIUM TEMPERATURES. K. H. Hellwege, R. v. Klot, and G. Weber (Technische Hochschule, Darmstadt, Ger.). Phys. Letters, 9: 95-6(Apr. 1, 1964). (In German)

The complex susceptibility of $CeCl_3 \cdot H_2O$ crystals in alternating magnetic fields between 5 and 2260 cps was measured and discussed using the dispersion-absorption method. The frequency dependent susceptibility is shown as a function of $H_c$ for temperatures of 3.46 and 1.92°K. Doppler relaxation was observed at magnetic field regions of 1185 and 3245 Oe and the corresponding frequency dependent time constants were found to be 3.2 and 2.75 ms. No Doppler relaxation was observed at 1610 and 2430 Oe. (L.B.S.)

**22830** SUPERCONDUCTING HUME-ROTHERY PHASE M. F. Merriam (Univ. of California, San Diego, La Jolla). Phys. Letters, 9: 100-1(Apr. 1, 1964)

The superconducting transition in the silver–mercury gamma phase is shown, and the temperature width, differential paramagnetic effect, and transition reversibility are noted. (L.B.S.)

**22831** HOMOGENISATION OF A MAGNETIC FIELD WITH A SUPERCONDUCTING CYLINDER. W. L. Williams, M. J. Stephen, and C. T. Lane (Yale Univ., New Haven). Phys. Letters, 9: 102-3(Apr. 1, 1964).

The apparatus and procedure for producing a homogeneous magnetic field are described. The field configuration trapped in a Sn cylinder and Pb guard rings shows homogeneity to at least 400 ppm over an axial distance of 5 cm. (L.B.S.)

**22832** DEMONSTRATION BY NEUTRON DIFFRACTION OF MAGNETIC FIELD PERIODIC STRUCTURE IN NIOBIUM SUPERCONDUCTORS. D. Cribier, B. Jacrot, L. Madhav Rao, and B. Farnoux (Centre d'Etudes Nucleaires, Saclay, France). Phys. Letters, 9: 106-7(Apr. 1, 1964). (In French)

A magnetic field is induced in type-2 superconductors between 2 values of an applied magnetic field. The structure of the induced field is asked. Diffracted neutron intensity vs applied field was measured for a pure superconducting niobium sample at various angles. The background intensity for a much larger applied field was subtracted to obtain the angular distribution of neutrons scattered by the induced magnetic structure. The scattering is characterized by an interference fringe; thus the existence of a periodic structure for the induced field is proved. The period is a function of the applied field. The specific model for the structure—whether of turbulent lines or of layers—could not be chosen. (M.J.T.)

**22833** EFFECT OF LONGITUDINAL MAGNETIC FIELDS ON CRITICAL CURRENTS OF TYPE II SUPERCONDUCTORS. J. W. Heaton and A. C. Rose Innes (Services Electronics Research Lab., Baldock, Herts, Eng.). Phys. Letters, 9: 112-13(Apr. 1, 1964).

The critical currents in $^{45}Ta$–$^{55}Nb$ wires were measured in longitudinal magnetic fields at 4°K. The critical currents decrease as the magnetic field increases from zero in agreement with calculations, but as the field approaches $H_{c1}$, a sharp increase in the critical current is observed indicating that the current is not confined to the surface but flows through the body of the metal. (L.B.S.)

**22834** THE THERMAL CONDUCTIVITY OF SOLID $He^4$ IN THE $\gamma$ PHASE. R. Berman and S. J. Rogers (Clarendon Lab., Oxford). Phys. Letters, 9: 115-17 (Apr. 1, 1964).

The thermal conductivity of solid helium-4 was measured at different densities and the variations with increasing temperature are interpreted. A rather flat region of low conductivity was found at densities at which bcc phases would be expected. The variations of the mean free path of phonons in the umklapp process was examined, and the kinetic equation of the thermal conductivity is presented. (L.B.S.)

**22835** ON THE THERMODYNAMIC PROPERTIES OF $H_2$–$D_2$ SOLID MIXTURES. M. Simon (Universite, Brussels). Phys. Letters, 9: 122-3(Apr. 1, 1964).

Measurements of the total vapor pressure for solid $pH_2$–$oD_2$ mixtures yielded an excess free energy of 3.2 cal/mole and thus an estimate for the critical temperature for phase separation of ≈3°K is derived. Heating curves were obtained from a thermal analysis between 10 and 20°K. (L.B.S.)

**22836** PHASE DIAGRAM OF $He^3$–$He^4$ MIXTURES. P. M. Tedrow and D. M. Lee (Cornell Univ., Ithaca, N. Y.). Phys. Letters, 9: 130-3(Apr. 1, 1964).

Five phases of $^3He$–$^4He$ mixtures are considered: $^4He$ rich liquid, $^3He$ rich liquid, a hexagonal close-pack solid, a bbc solid rich in $^4He$, and a bbc solid rich in $^3He$. Pressure-temperature and pressure-concentration diagrams are presented and discussed. (L.B.S.)

**22837** RESISTIVE TRANSITION AND CURRENT DENSITY CHARACTERISTICS IN SUPERCONDUCTING NIOBIUM CONTAINING DISSOLVED GASES. Warren DeSorbo (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 134: A1119-35(June 1, 1964).

Oxygen and nitrogen as interstitial solutes in niobium cause the metal in transverse field to exhibit anomalous resistance minima or critical current maxima (peak effect). The anomaly appears at $H_{c2}$, the upper critical field of these Type-II superconductors. The resistance in the mixed state is decreased by exceeding solubility limit, by cold working, and by strain aging at 170°C, masking out the anomaly. Rapidly quenching from the solution temperature decreases the anomaly. The results suggest that the anomaly is strongest at some intermediate stage of the process of segregation and precipitation at dislocations. Resistance in the mixed state is increased by introducing more solute, by quenching, and by etching. Structural changes brought about by cold working, strain aging, and rapid quenching responsible for large changes in $J_c(H)$ or $R(H)$ in the mixed state also cause changes in the region $H_{c2} < H < H_{c3}$. In this latter region, field orientation effects and observed $H_{c3}/H_{c2}$ ratios are roughly consistent with the concept of a superconducting surface sheath as recently proposed by Saint-James and de Gennes. Pure niobium, however, tends to exhibit consistently higher ratios. (auth)

**22838** EFFECT OF MAGNETIC FIELD ON THERMAL CONDUCTIVITY AND ENERGY GAP OF SUPERCONDUCTING FILMS. D. E. Morris and M. Tinkham (Univ. of California, Berkeley). Phys. Rev., 134: A1154-66(June 1, 1964).

The change in the thermal conductivity of superconducting tin, indium, and lead films upon application of a magnetic field in the plane of the film was measured. These experiments were undertaken to explore the dependence of the energy gap upon magnetic field and to determine the thermodynamic order of the field-induced transition in films. Within the range of temperatures available to us (0.35 to 0.65 $T_c$) the thermal conductivity of indium and tin films increases nearly as $H^2$. In films of thickness $d \geq 2800$ Å the thermal conductivity jumps at $H_c$ to the normal state value, indicating a first-order phase transition in thin films, consistent with the Ginzburg-Landau (GL) theory. If the effect of a field upon the superconducting state can be adequately represented as a change of the $\epsilon_0$ of BCS, the theory of Bardeen, Rickayzen, and Tewordt may be used to compute $\epsilon_0(H)$ from the data. At $T = 0.65\ T_c$ it is found that $\epsilon_0(H)/\epsilon_0(H=0) = [1-(H/H_c)^2]^{1/2}$ in agreement with the GL prediction. At $T = 0.35\ T_c$ however, $\epsilon_0(H)/\epsilon_0(0) = 1-(H/H_c)^2$ provides a more satisfactory fit to the data. Orientation of the field $\perp$ and $\parallel$ to the direction of heat flow produces the same effect on the thermal conductivity to ±1%. This is interesting in view of Bogoliubov's prediction of a $p_F \cdot v_{drift}$ term in the excitation spectrum of a current-carrying superconductor. When the field is not parallel to the surface of the film the thermodynamic transition is still sharply defined, but $H_c$ is reduced. Thin lead films gave results similar to those of indium and tin films except that at low fields the field-dependent conductivity increased more slowly than $H^2$ at low temperatures. (auth)

**22839** THEORY OF SOLID NEON AT 0°K. William J. Mullin (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., 134: A1249-54(June 1, 1964).

A quantum-mechanical variational calculation of the energy per particle, the equilibrium nearest-neighbor distance, and the pressure-volume relation for solid neon at 0°K is performed. Use is made of a Jastrow-type trial wave function, a phenomenological Mie-Lennard-Jones 12–6 potential, and a cluster expansion evaluation of the energy expectation value. It is found that correlation effects are negligible at equilibrium, contrary to the speculations of some authors, and that good agreement with the experimental data can be achieved if one of the interparticle potential parameters, $\epsilon$, is changed by a small amount from its accepted gas-phase value. This parameter change is discussed. (auth)

**22840** SPECIFIC HEAT OF NIOBIUM BETWEEN 0.4 AND 4.2°K. B. J. C. van der Hoeven, Jr., and P. H. Keesom (Purdue Univ., Lafayette, Ind.). Phys. Rev., 134: A1320-1(June 1, 1964).

Below 3.3°K, the normal-state specific heat of niobium, measured in a magnetic field of 17 kG, can be represented by $C_n = 7.79T + 0.094T^3$ mJ/mole deg. This corresponds to a value of the Debye parameter at 0°K, $\theta(0)$, of 275°K. The specific heat in the superconducting state does not appear to be anomalous. (auth)

**22841** SUPERCONDUCTING AND NORMAL SPECIFIC HEATS OF A SINGLE CRYSTAL OF NIOBIUM. H. A. Leupold and H. A. Boorse (Columbia Univ., New York). Phys. Rev., 134: A1322-8(June 1, 1964).

The anomalous specific heat found in a polycrystalline sample of niobium and previously reported by Hirshfeld, Leupold, and Boorse (HLB) prompted complete remeasurements both in the normal and superconducting phases on a single crystal with lower tantalum content. The thermal constants of the single crystal show only small differences from the polycrystal in the same temperature range, the single-crystal values being $T_c = 9.20$°K and $\Theta = 241$°K between about 10 and 3°K. The normal-state single-crystal measurements agree with measurements on the HLB polycrystal made both in this laboratory and by van der Hoeven and Keesom at Purdue University. The latter measurements were carried to about 0.4°K in a field of 17 kG. As a result of their investigation, they report a Debye $\Theta$ of 275°K in the region below 3°K. With this value of $\Theta$, the anomaly in the specific heat disappears. As both the single-crystal results and the van der Hoeven and Keesom values agree in the mutually measured ranges, $\Theta$ is taken to be 275°K. The corresponding value of $\gamma$ is found to be 7.80 mJ/mole deg$^2$. The usual exponential behavior of the electronic specific heat $C_{es}/\gamma T_c = ae^{-bT_c/T}$ with a = 8.21 and b = 1.52, is observed over a restricted temperature range. Below $t = 5$ the data exhibit larger values than predicted by the exponential in agreement with a number of other superconductors. The value of the energy gap at 0°K was found to be 3.69 $kT_c$. Overall comparisons are made with the BCS theory and a modification due to Swihart. (auth)

**22842** SURFACE BARRIER IN TYPE-II SUPERCONDUCTORS. R. W. De Blois and W. De Sorbo (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev. Letters, 12: 499-501(May 4, 1964).

The experimental observation of a greatly enhanced superconducting to mixed-state transition field in regions of electropolished specimens of $Nb_{0.933}O_{0.067}$ and $Nb_{0.33}Ta_{0.67}$ is reported. The results are consistent with

predictions that a type-II-superconductor plane surface produces a nucleation barrier increasing the initial flux penetration field to near the thermodynamic critical field, and that surface roughening permits flux penetration near the superconducting to mixed-state transition field. (M.J.T.)

**22843** SUPERCONDUCTIVITY OF SOLID SOLUTIONS OF TaC AND NbC. Molly Wells, Milton Pickus, Kurt Kennedy, and Victor Zackay (Univ. of California, Berkeley). Phys. Rev. Letters, 12: 536-8(May 11, 1964).

The preparation of the solid solutions is described. Variations of critical temperature and lattice parameter vs composition are given. It is concluded that parameters used to describe superconductivity of intermetallic compounds are insufficient for solid solutions of transition-metal and interstitial-element compounds. (M.J.T.)

**22844** CRYOGENIC TECHNOLOGY. Robert W. Vance, ed. University of California Engineering and Physical Sciences Extension Series. New York, John Wiley and Sons, Inc., 1963. 599p. $19.50.

Applications and basic theoretical studies of cryogenic technology are stressed in the 15 sections. Separate abstracts were prepared for 3 of the sections; the remaining topics include the production of low temperatures, properties of solids and liquids, phase equilibria, heat transfer, measurement of low temperatures, optical masers, cryogenic pumping and space simulation, explosion hazards in propellants, cryogenic problems in space, and cryobiology. Numerous references. (R.E.U.)

*For abstracts of individual chapters see: 22845, 22846, and 22847.*

**22845** FUNDAMENTALS OF SUPERCONDUCTIVITY. J. K. Hulm (Westinghouse Electric Corp., Pittsburgh). p.251-90 of "Cryogenic Technology." New York, John Wiley and Sons, Inc., 1963.

The basic macroscopic theory of superconductivity is reviewed, and the electric, magnetic, and thermodynamic properties of "hard" and "soft" superconductors are discussed. (R.E.U.)

**22846** APPLICATIONS OF SUPERCONDUCTIVITY. T. A. Buchhold (General Electric Research Labs., Schenectady, N. Y.). p.291-310 of "Cryogenic Technology." New York, John Wiley and Sons, Inc., 1963.

Various applications of superconductors are described, including the cryotron switching system, superconductive bearings, current standards, motors, transformers, cables, magnetic shielding, and high-frequency and high-field applications. (R.E.U.)

**22847** NUCLEAR PROPULSION. F. J. Edeskuty (Los Alamos Scientific Lab., N. Mex.). p.352-74 of "Cryogenic Technology." New York, John Wiley and Sons, Inc., 1963.

Cryogenic aspects of nuclear propulsion are discussed. The Rover Program and the Jackass Flats, Nevada, test facility are described. (R.E.U.)

## Neutron Physics

**22848** (GA-4659) INTEGRAL NEUTRON THERMALIZATION. Annual Summary Report, October 1, 1962–September 30, 1963. J. R. Beyster, J. R. Brown, J. U. Koppel, J. M. Neill, J. L. Russell, Jr., G. D. Trimble, J. A. Young, and J. C. Young (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Jan. 24, 1964. Contract AT(04-3)-167. 200p.

Analytical, experimental, and theoretical research on neutron thermalization is reported. The experimental facilities, procedures, and equipment are discussed. (D.C.W.)

**22849** (HW-80020(p.23-30)) AN ORTHONORMAL SERIES EXPANSION FOR THEORETICAL-EXPERIMENTAL FLUX COMPARISONS. D. R. Skeen and C. R. Richey (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A method is described for calculating correction functions that indicate the regions in which the theoretical flux is in error. The coefficients of the correction functions are calculated from experimental and theoretical reaction rates. The method was tested by thermal flux calculations for plutonium nitrate solutions. (D.C.W.)

**22850** (HW-80020(p.31-7)) CRITICAL EXPERIMENTS WITH $PuO_2$–POLYSTYRENE COMPACTS. C. R. Richey, J. D. White, R. C. Lloyd, and E. D. Clayton (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The compacts used in the experiments have a Pu concentration of 1.12 g/cm$^3$ and a H/Pu atom ratio of 15. The density of the polystyrene is 0.931 g/cm$^3$. The effects on the criticality of arrays of the rubberized plastic coating on each compact and of the fuel-removal safety and control rods were determined. Comparative reflector savings for water, Lucite, and a 3% enriched uranyl nitrate solution were measured. The effect of core density change on the criticality of a Lucite reflected prism was also investigated. (D.C.W.)

**22851** (LA-2996) NUMERICAL FORMULATION AND SOLUTION OF NEUTRON TRANSPORT PROBLEMS. Bengt G. Carlson (Los Alamos Scientific Lab., N. Mex.). Nov. 11, 1963. Contract W-7405-eng-36. 50p.

The numerical techniques for solving the neutron transport equation in arbitrary geometry in the case of discrete treatment of neutron velocity and direction are summarized. The transport problems considered may be stationary or time-dependent and may involve isotropic or anisotropic sources with or without up-scattering. The special case of the diffusion approximation is also briefly discussed. (auth)

**22852** (NAA-SR-9233) QUICKIE—A COMPUTER PROGRAM FOR SPATIALLY INDEPENDENT MULTIGROUP SLOWING-DOWN AND THERMALIZATION CALCULATIONS. M. Boling and W. Rhoades (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 15, 1964. Contract AT(11-1)-Gen-8. 51p.

The program QUICKIE solves the neutron slowing down and thermalization equations without consideration of spatial dimensions. The multi-group diffusion equations are converted to spatially independent equations involving only integrated fluxes. The calculational procedures are outlined, and input data are described. The program listing and sample input and output are included. (D.C.W.)

**22853** A NEW AND EXPEDIENT VARIETY OF THE TANK ACTIVATION METHOD FOR YIELD DETERMINATION OF Po–Be NEUTRON SOURCES. P. Adler and A. Ohnesorge (Institut fllr Angewandte Radioaktivitat, Leipzig). Atomkernenergie, 9: 113-14(Mar.-Apr. 1964). (In German)

An apparatus for routine determination of the absolute strength of Po–Be neutron sources is described. The source to be calibrated is located in a bath of an aqueous manganese sulfate solution. The value of the absolute neutron emission of the source can be calculated from the increase, recorded by a calibrated flow-counter, of the integral specific activity of the indicator solution, if certain correction factors are taken into account. (auth)

**22854** A TECHNIQUE FOR PULSED NEUTRON GENERATOR FLUX EVALUATION. J. Robert Boland (Nuclear Effects Lab., White Sands Missile Range, N. Mex.). Health Phys., 10: 271-2(Apr. 1964).

A technique is presented using a thick copper foil and utilizing the $^{63}Cu(n,2n)^{62}Cu$ reaction of copper for determining the flux from a pulsed neutron generator. The pulse neutron generator produces 14.2 Mev neutrons by the interaction of deuterium and tritium. The foil is activated, counted, and the integrated flux in $n/cm^2$ is calculated. Having a value of integrated flux at a given location, the integrated flux at any given point near the target can be deduced by using total flux distribution tables. The tables were prepared on the assumption that the source is a thin, planar, isotropic, radiating disk. (auth)

**22855** ON SOME CONJECTURES IN NEUTRON TRANSPORT THEORY. P. H. Diananda (Univ. of Singapore, China). J. Math. Mech., 12: 635-42(Sept. 1963).

A one-dimensional homogeneous rod of fissionable material is considered, and it is assumed that a neutron, entering into a collision within the rod, is replaced by two neutrons which move in opposite directions along the rod and that the neutrons reaching the ends are lost permanently. Some probabilistic lemmas are considered. (R.E.U.)

**22856** THE NEUTRON TRANSPORT AS IRREVERSIBLE PROCESS. G. Helmis (VEB Atomkraftwerk, Berlin). Kernenergie, 7: 156-8(Mar. 1964). (In German)

The Kikuchi method (Phys. Rev., Vol. 124: 1961, pp.1682 and 1691) was extended to cover particle absorption and particle multiplication. The purpose was to investigate irreversible processes in the course of neutron transport. The neutron transport equation was derived from the principle of maximum persistence. The calculations presented pertained to monoenergetic neutrons; however, an analogous technique would apply to energy-dependent neutron distribution. (P.C.H.)

**22857** SHORT DESCRIPTION OF NGDR PROGRAMME SYSTEM (N-GROUP DIFFUSION CALCULATIONS) FOR THE COMPUTER ZRA 1. W. Bergmann (Zentralinstitut für Kernforschung, Rossendorf, Ger.). Kernenergie, 7: 184-5(Mar. 1964). (In German)

The three principal variants, problems of capacity and program organization, and computing times are discussed for the N-group diffusion calculating program of the ZRA-1 computer. (P.C.H.)

**22858** 300 kev COCKCROFT-WALTON TYPE NEUTRON GENERATOR. Shigeyoshi Ogura (Mitsubishi Atomic Power Industries, Inc., Japan), Masahiro Mukae, Gen Imamura, Hyoto Fujita, Yasuhiro Yokota, Masayuki Gotoh, Toshimitsu Akiba, and Akio Nagai. Mitsubishi Denki Lab. Rept., 4: 199-23(Apr. 1963).

The machine described is a Cockcroft-Walton type particle accelerator designed and manufactured as a neutron source for the subcritical facility with a light-water moderator. The design features of this machine cover the maximum accelerating voltage of 300 kv, the neutron yield of more than $10^{10}$ n/s with pulsed operations at either a light-water moderator or a graphite pedestal by means of D-D and D-T reactions. Experimental results obtained up-to-date revealed that the maximum accelerating voltage is 350 kv and the neutron yield has a potentiality of more than $10^{10}$ n/s. (auth)

**22859** A MONTE CARLO METHOD FOR THE ANALYSIS OF GAMMA RADIATION TRANSPORT FROM DISTRIBUTED SOURCES IN LAMINATED SHIELDS. Martin Leimdoerfer (Research Inst. of National Defence, Stockholm). Nukleonik, 6: 58-65(Mar. 1964).

A description is given of a method for calculating the penetration and energy deposition of gamma radiation, based on Monte Carlo techniques. The essential feature is the application of the exponential transformation to promote the transport of penetrating quanta and to balance the steep spatial variations of the source distributions which appear in secondary gamma emission problems. The estimated statistical errors in a number of sample problems, involving concrete shields with thicknesses up to 500 cm, are shown to be quite favorable, even at relatively short computing times. A practical reactor shielding problem is also shown and the predictions compared with measurements. (auth)

**22860** SLOW NEUTRON INELASTIC SCATTERING FROM LIQUID SODIUM. P. D. Randolph (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Rev., 134: A1238-48 (June 1, 1964).

Partial differential cross sections for slow neutron scattering from liquid sodium were measured at 100, 150, and 200°C. The Materials Testing Reactor phased-chopper velocity selector was used with a 95% transmission sample at incident neutron energies of 0.025, 0.07, and 0.10 ev at eight scattering angles (16 to 85°). In the scattering law obtained from these cross sections, prominent coherent scattering maxima appear for energy transfers $\Delta E \geq 0.2\ k_BT$, but disappear beyond $\Delta E = 0.3\ k_BT$. At each temperature, time-dependent widths $\rho(t)$ of the intermediate scattering function were obtained by Fourier transformation of the scattering law for large momentum transfers. At times $<1 \times 10^{-13}$ sec these functions confirm the prediction of gas-like behavior, but at larger times are solid-like. The $\rho(t)$'s are also momentum-dependent at larger times indicating that the self-correlation function is not strictly Gaussian. Measurements of the zeroth and first moments of the energy transfer were obtained from the scattering law at each temperature for several values of momentum transfer. The zeroth moment is in agreement with neutron diffraction experiments, but the first moment is as much as a factor of 2.5 larger than predicted theoretically. (auth)

**22861** CORRECT METHOD OF EVALUATION OF AVERAGE ENERGY OF NEUTRONS AFTER n-COLLISIONS. Kerim F. Slipičević (Université, Belgrade). Publ. Elektroteh. Fak. Univ. Beogradu, Ser., Mat. i Fiz., No. 111, 21-2(1963).

A method is outlined for determining the average energy of neutrons, when scattering is isotropic in the center-of-mass system, for properly chosen frequency functions. (R.E.U.)

**22862** SCATTERING OF THERMAL NEUTRONS FROM SOLIDS AND THEIR THERMALIZATION NEAR EQUILIBRIUM. L. S. Kothari and V. P. Duggal (Univ. of Delhi). p.185-302 of "Advances in Nuclear Science and Technology. Vol. 2." New York, Academic Press, 1964.

Topics discussed include models for scattering cross sections, transport cross sections and diffusion constant, the Fermi age, slowing down relaxation time, diffusion cooling constant, and neutron energy spectra calculations and measurements. 273 references. (R.E.U.)

## Nuclear Properties and Reactions

**22863** (AD-417228) RESONANCES IN THE YIELD CURVE OF THE $Si^{30}(p,\gamma)P^{31}$ REACTION ($E_p$ = 1.5 TO 3.0

Mev RANGE) (thesis). Richard M. Roberds (Kansas. Univ., Lawrence). July 1963. 44p.

Yield curves for $^{30}Si(p,\gamma)^{31}P$ at 1.5 to 3.0 Mev were obtained using targets with thicknesses of 6 and 1.2 kev. The targets were metallic Si highly enriched in $^{30}Si$, and gamma rays were detected by a NaI(Tl) scintillation crystal coupled to a photomultiplier tube and preamplifier. More resonance levels were resolved than in previous studies, particularly with the thinner target. (D.C.W.)

**22864** (ANL-6814) A COMPARISON OF NUCLIDIC MASS EQUATIONS WITH EXPERIMENTAL DATA. James Wing (Argonne National Lab., Ill.). Jan. 1964. Contract W-31-109-eng-38. 86p.

Existing mathematical expressions for the systematics of the nuclidic masses, binding energies, and nucleon separation energies are summarized. The calculated values of the nuclidic mass equations of Fermi, Román, Bussetti, Cameron, Tsen, Findler, Seeger, Ayres et al., Kümmel et al., Thieberger et al., Zeldes, Green, Levy, Baker, and Wing-Fong (a new mass equation) are compared with the available experimental data. Improvements are suggested for some of the observed deviations in these equations. Some expressions for the isobaric parameters $B_A$ and $Z_A$ (nuclear charge of the most stable isobar), and for the pairing and shell effects are compared with the experimental evidence. An improved empirical formula for $Z_A$ and empirical equations for the deformation parameter $\beta$ are presented. (auth)

**22865** (CONF-481-40) VARIOUS TYPES OF FLUCTUATIONS IN THE $C^{12}(C^{12},\alpha)Ne^{20}$ REACTION. R. B. Leachman (Institut for Teoretish Fysik, Copenhagen and Los Alamos Scientific Lab., N. Mex.). [1964]. Contract W-7405-eng-36. 19p.

From American Physical Society Annual Meeting, New York, Jan. 1964.

The angular distributions, cross sections, and excitation functions for $^{12}C(^{12}C,\alpha)$ reactions to low-lying levels of $^{20}Ne$ were studied. The data are in accord with the compound nucleus theory, and no significant contribution of direct interactions or isolated levels is required to explain the data. The cross section data confirm in detail the various fluctuations expected from statistical theory. (auth)

**22866** (CONF-481-41) INELASTIC ELECTRON SCATTERING FROM $Ca^{40}$ IN THE GIANT RESONANCE REGION. L. J. Weigert and J. M. Eisenberg (Virginia. Univ., Charlottesville). [1963]. Contract AT(40-1)-2400. 27p.

From American Physical Society Annual Meeting, New York, Jan. 1964.

Matrix elements for the excitation of particle-hole states in $^{40}Ca$ by inelastic electron scattering are calculated. Electric dipole transitions to T = 1 states are considered, taking into account both transverse and Coulomb contributions. The particle-hole matrix elements are evaluated for a zero-range residual interaction. With the help of angular momentum identities, these matrix elements are expressed in a form involving only two Clebsch-Gordan coefficients, thus eliminating the usual 9-j symbols. Wave functions for the excited states are obtained from the diagonalization of the secular matrix. As functions of momentum transfer, some of the matrix elements for the electroexcitation of the different energy levels exhibit characteristically different behavior, thus helping to identify these levels in the extended shell model scheme. Varying the parameters of the residual interaction over a reasonable range brings about minor modifications in this behavior, but the qualitative results do not depend critically on the choice of these parameters. The sum of the contributions from the four energy levels above threshold, as a function of momentum transfer, proves to be extremely insensitive to changes in the parameters of the residual interaction, thus exhibiting the effects of closure. (auth)

**22867** (CONF-481-44) GAMMA-RAY SPECTRA FROM LOW-ENERGY NEUTRON CAPTURE IN COPPER. Oren A. Wasson and James E. Draper (Yale Univ., New Haven). [1963]. Contract AT(30-1)-1349. 12p.

From American Physical Society Annual Meeting, New York, Jan. 1964.

The gamma energy spectra from thermal neutron capture and from capture in the two lowest resonances (230 and 590 ev) in natural copper were measured and compared. A large decrease in the intensity of the 7.91-Mev ground state transition was observed in going from thermal to 590-ev neutron energy. It was concluded that this observation does not negate the hypothesis that thermal neutron capture in $^{63}Cu$ is direct. (D.C.W.)

**22868** (CONF-481-45) ABSENCE OF STATES IN $Be^8$ AT 7.56, 13.91 AND 18.00 Mev. P. D. Miller, J. L. Duggan, and M. M. Duncan (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 13p.

From American Physical Society Annual Meeting, New York, Jan. 1964.

The $^7Li(p,\alpha)\alpha$ and $^7Li(p,\gamma)^8Be$ reactions were studied in an effort to confirm recently reported states in $^8Be$ at energies of 7.56, 13.91, and 18.00 Mev. The alpha particles assigned to the state at 7.56 Mev are shown to be attributable to the $^{18}O(p,\alpha_0)^{15}N$ reaction. The alphas assigned to a state at 13.91 Mev are shown to result from the $^{19}F(p,\alpha_0)^{16}O$ reaction. The postulation of a state at 18.00 Mev was based upon the presumed resonant formation of $^{8*}Be$ which decayed by gamma emission to the states at 7.56 and 13.91 Mev, followed by alpha breakup of these states. Since both of the alpha groups are assigned to contaminants, this state is also not confirmed. Resonances reported from the $^7Li(p,\gamma_0)^8Be$ and $^7Li(p,\gamma_1)^{8*}Be$ (2.9 Mev) reactions at 0.72 and 0.87 Mev bombarding energy are also not observed. (auth)

**22869** (CONF-481-48) ALPHA PARTICLE ANGULAR DISTRIBUTION INFORMATION FROM RECOIL RANGE MEASUREMENTS OF REACTIONS INDUCED IN $Ni^{58}$ WITH 46 TO 68 Mev HELIUM IONS. Marshall Blann and Alan Ewart (Rochester, N. Y. Univ.). [1963]. Contract W-7405-eng-49. 35p.

From American Physical Society Annual Meeting, New York, Jan. 1964.

Ranges in $^{58}Ni$ are reported for $^{54}Ni$, $^{57}Ni$, $^{55}Co$, $^{56}Co$, $^{57}Co$, and $^{56}Co$ recoil ions resulting from the bombardment of $^{58}Ni$ with 46 to 68 Mev He ions. The thick target-thick catcher method was used to obtain average recoil ranges in the beam direction. Measured ranges were compared with theoretical range predictions, calculated assuming full momentum transfer from the incident helium ions to the recoil ions. Theoretical range curves were corrected for the influence of alpha particle and nucleon evaporation. Experimental ranges measured from reaction thresholds to excitation function peaks agree with the corrected theoretical curves to within 10%. Recoil ranges for $^{57}Co$ and $^{57}Ni$ are shown to have predominate contributions from a low momentum transfer process in the energy range corresponding to the high energy tail of the excitation functions. At higher energies the ranges, and excitation functions are shown to increase, consistent with the onset of $^{58}Ni$ ($\alpha$, 5 nucleon) compound nucleus reaction contributions. Recoil

ranges for $^{55}Co$, $^{56}Co$, and $^{58}Co$ are consistent with full momentum transfer over the entire energy range studied, including those ranges corresponding to the high energy tail of the $^{56}Co$ excitation function. Recoil ranges for $^{56}Ni$ are consistent with full momentum transfer up to the peak of the excitation function, after which the range decreases sharply as a competing low momentum transfer reaction becomes predominant. The details of the reaction mechanism responsible for the high energy tails of the $^{57}Ni$, $^{57}Co$, and $^{56}Ni$ excitation functions are discussed. In the case of the excitation function for the formation of $^{56}Ni$, evidence is presented that the interaction is between the incident helium ion and one or two neutrons, rather than an $(\alpha,\alpha')$ inelastic scattering followed by nucleon evaporation. It is concluded that these two mechanisms in the case of the reactions forming $^{57}Ni$ and $^{57}Co$ cannot be differentiated. (auth)

**22870** (CONF-481-50) POLARIZATION OF PROTONS IN THE $He^3(d,p)He^4$ REACTION. Technical Report 348. H. L. Fann and R. W. Detenbeck (Maryland. Univ., College Park). Jan. 1964. Contract AT(30-1)-2464. 20p.

The polarization of protons from the $^3He(d,p)^4He$ reaction was studied at incident deuteron energies of 1.49, 2.06, and 2.63 Mev for outgoing proton angles between 30° and 150° in the laboratory system. The target was a $^3He$ gas cell at 152 cm Hg pressure. The polarimeter detected, in nuclear emulsions, protons scattered from $^4He$ gas at 18 atm. The polarization of the scattered protons was determined by measuring the left-right asymmetry of the elastically scattered protons, using the double-scattering method. A proton polarization of $-21 \pm 4\%$ (Basel convention) was observed at a laboratory angle of 60° with an incident deuteron energy at 2.63 Mev at the center of the gas cell. For $E_d = 2.06$ Mev, the polarization shows a negative broad extreme near a laboratory angle of 60° and decreases to zero for backward angles. The effective polarization of the p-$^4He$ analyzer was derived from a study of the p-$^4He$ phase shifts. A measurement of the asymmetry of protons from the reaction at resonance shows that the analyzer's inherent asymmetry is less than 0.01. The inherent asymmetries due to finite geometry and possible misalignments of the experimental apparatus were calculated. These were found to give negligible corrections to the measurements. (auth)

**22871** (CONF-502-1) HARTREE-FOCK CALCULATIONS FOR SPHERICAL NUCLEI. A. K. Kerman (Massachusetts Inst. of Tech., Cambridge) and A. M. Lockett (Brookhaven National Lab., Upton, N. Y.). Apr. 24, 1964. Contract AT(30-1)-2098. 4p.

A computer program was developed for calculating the conventional Hartree-Fock potential, wave functions, and energies of spherical nuclei. The program uses an arbitrary, finite, nonlocal, two-body force including spin and isospin exchange terms and tensor forces. Hard cores are handled by making their height finite. (auth)

**22872** (CONF-502-3) POLARIZATION OF PHOTONEUTRONS FROM D, $O^{16}$ AND $C^{12}$. W. Bertozzi, P. Demos, F. Hanser, S. Kowalski, C. Sargent, W. Turchinetz (Massachusetts Inst. of Tech., Cambridge); R. Fullwood, and J. Russell (Rensselaer Polytechnic Inst., Troy, N. Y.). [1963]. Contract AT(30-1)-2098. 4p.

From International Congress of Nuclear Physics, Paris, July 1964.

The polarization of photoneutrons from D, $^{16}O$ and $^{12}C$ was measured at 45 and 90° to the photon beam for a bremsstrahlung energy of 30 Mev. For 6 Mev $< E_\gamma <$ 22 Mev the results for D are smaller than predicted by theory. The data from $^{16}O$ and $^{12}C$ at 90° show very small polarization. Large polarizations are obtained from $^{16}O$ at 45°. (auth)

**22873** (NP-13838) REACTIONS NUCLEAIRES DE SPALLATION INDUITES SUR LE THORIUM PAR DES PROTONS DE 150 Mev (THESES). (Spallation Nuclear Reactions Induced by 150-Mev Protons on Thorium (thesis)). Gabriel Simonoff (Paris. Université). 1961. 94p.

The spallation of thorium by 150-Mev protons was studied. The irradiation characteristics of the target are indicated, and the various radiochemical separation techniques used are described. The methods for the absolute measurement of alpha decay, beta decay, and electron capture are discussed. The apparatuses constructed for the measurements, and particularly the electron collection ionization chambers, are described. Each isotope was identified and the absolute cross sections of $^{232}Pa$, $^{230}Pa$, $^{229}Pa$, $^{228}Pa$, $^{227}Pa$, $^{231}Th$, $^{229}Th$, $^{228}Th$, $^{227}Th$, $^{226}Th$, $^{225}Th$, $^{228}Ac$, $^{227}Ac$, $^{226}Ac$, $^{225}Ac$, $^{224}Ac$, $^{227}Ra$, $^{225}Ra$, $^{224}Ra$, $^{223}Ra$, $^{223}Fr$, $^{221}Fr$, and $^{212}Fr$ were determined. These results are interpreted by the mechanism of spallation. The calculation was in three stages: (1) determination of the distribution of excitation energies of nuclei resulting from the direct interaction; (2) evaluation of the mean number of neutrons emitted for each excitation energy; and (3) intervention of the ratio $\Gamma_n/\Gamma_f$ between the probability of neutron emission and fission probability during the evaporation chain. The cross sections for the reactions (p,xn), (p,pxn) and (p,2pxn) were thus obtained. They were in good agreement with the experimental values. (tr-auth)

**22874** (PAN-476/II) ODDZIALYWANIE FRAGMENTOW ROZSZCZEPIENIA Z PRZEJSCIEM n-p. (Interaction of Fission Fragments With n-p Junction). B. Buras, M. Dakovskii, M. Sovinskii, and Ya. Khashchevskaya (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). 1963. 10p.

The energy distribution of fission fragments of $^{235}U$ bombarded with reactor neutrons was studied by means of silicon surface barrier detectors as a function of: polarization field applied to the detector, homogeneity of the silicon used, and charge collection time. The results obtained show the presence of ionization defect and a high energy tail and a dependence of these effects on the electric field applied, homogeneity of the silicon used, and the charge collection time. A preliminary explanation of the results obtained is given. (auth)

**22875** (UCRL-7740) SINGLE-PARTICLE EXCITATION THEORY OF THE PHOTONUCLEAR GIANT RESONANCE. F. Buskirk (California. Univ., Livermore. Lawrence Radiation Lab.). July 30, 1963. Contract W-7405-eng-48. 18p.

Calculations of the photonuclear giant resonance according to the Wilkinson model are presented. In this model the giant resonance in the cross section for absorption of gamma rays by nuclei is ascribed to the excitation of large numbers of nucleons in closed shells. The model generally predicts correctly the integrated cross section for the giant resonance, but the resonance energy is too low. Results are presented in a series of tables and formulas so that the integrated cross section may be calculated for any given nucleus. (auth)

**22876** (UCRL-11169) THE BETA-DECAY ASYMMETRY AND NUCLEAR MAGNETIC MOMENT OF NEON-19 (thesis). David Albert Dobson (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 20, 1963. Contract W-7405-eng-48. 105p.

The asymmetry parameter in the angular distribution of decay positrons from polarized $^{19}Ne$ nuclei was measured.

An atomic beam of $^{19}Ne$ was passed through an inhomogeneous magnetic field and one of the polarized, deflected half-beams was collected in a cylindrical glass bulb with thin end walls. Nuclear spin polarization is preserved during wall collisions in the bulb, as predicted by consideration of nuclear spin relaxation mechanisms. Decay positrons pass through the thin end walls of the bulb and are counted with Geiger counters. A difference was observed between the number of positrons emitted parallel and antiparallel to the spin polarization axis. The asymmetry parameter is calculated from the observed difference in positron counting rates. If the polarized $^{19}Ne$ half-beam is passed through a homogeneous static magnetic field before it is collected in the bulb and the magnetic dipole transition between spin states is induced with a radio-frequency magnetic field, the observed difference in positron counting rates is reversed. The magnetic moment of $^{19}Ne$ is calculated from the resonance frequency and the static magnetic field intensity, measured with an NMR gaussmeter. Appropriate methods of estimating the beta-decay coupling constants for $^{19}Ne$ are discussed. The Fermi and Gamow-Teller matrix elements for $^{19}Ne$ are calculated from the measured asymmetry parameter and the ft value of $^{19}Ne$. A rotational-model calculation for $^{19}F$ is carried out with the spin-orbit parameter, deformation and moment of inertia of the nucleus adjusted so that the energies of three excited states agree with experimental values. Neglecting isotopic spin mixing due to Coulombic repulsion, the predicted nuclear matrix elements are $\langle 1 \rangle = 1.00$ and $\langle \sigma \rangle = -1.55$. The predicted magnetic moments for $^{19}F$ and $^{19}Ne$ are 2.74 and $-1.89$ nm, respectively. The predicted moment for $^{19}Ne$ is in good agreement with the measured value, but the predicted moment for $^{19}F$ is too large by 0.11 nm. This discrepancy may be accounted for by adding a spin-orbit coorection to the moment. The predictions of nuclear-model calculations by others are considered also. (auth)

**22877** THE BETA–GAMMA CORRELATION IN $Au^{198}$. J. E. Thun, S. Toernkvist, F. Falk, and F. Kropf (Inst. of Physics, Uppsala). Arkiv Fysik, 25: 509-11(1964).

The 960 kev beta-412 kev gamma correlation in the decay of $^{198}Au$ was measured at four different beta energies between 45 and 600 kev. No evidence was found for anomalies in the energy dependence of the correlation coefficient $A_2(W)$, which is proportional to $p^2/W$ within the error limits. (auth)

**22878** DEEXCITATION AND SPIN OF THE 3.56 Mev LEVEL IN $Na^{21}$. E. S. Arnell and S. Sterner (Chalmers Tekniska Högskola, Goteborg). Arkiv Fysik, 25: 531-40 (1964).

The deexcitation of the 3.56 Mev level in $Na^{21}$ was studied with scintillation spectrometry. A decay scheme is given. The spin is proposed to be $5/2^+$. (auth)

**22879** A DISPERSION-THEORETICAL EQUATION FOR THE TWO-NUCLEON BOUND STATE. B. O. Enflo (Univ. of Stockholm). Arkiv Fysik, 25: 545-65(1964).

The scalar amplitude for a nucleon current between a one-nucleon state and a one-deuteron state is investigated, and an integral equation for it is established. The method of reducing the amplitude is described and the approximations are discussed. (L.B.S.)

**22880** MEASUREMENT OF THE CIRCULAR POLARIZATION OF THE $Tl^{203}$ X-RAY QUANTA. H. Schneider (Justus Liebig-Universität, Giessen, Ger.). Atomkernenergie, 9: 137-42(Mar.-Apr. 1964). (In German)

The circular polarization of the $^{203}Tl$ x-ray quanta was measured by Compton forward scattering on magnetically saturated iron. The "fast-slow" coincidence arrangement used is described in detail. The 279-kev quanta, also emitted by $^{203}Tl$, influenced the experimental result. Their contribution is eliminated at the evaluation. The degree of polarization of the x-ray quanta is discussed. (auth)

**22881** FORMATION CROSS SECTIONS OF VARIOUS RADIONUCLIDES FROM Ni, Fe, Si, Mg, O, AND C FOR PROTONS OF ENERGIES BETWEEN 130 AND 400 Mev. Garimella V. S. Rayudu (Carnegie Inst. of Tech., Pittsburgh). Can. J. Chem., 42: 1149-54(May 1964).

Formation cross sections of $^{56}Co$, $^{54}Mn$, $^{52}Mn$, $^{51}Cr$, $^{48}V$, $^{32}P$, and $^{7}Be$ from Fe and Ni; of $^{24}Na$, $^{22}Na$, and $^{7}Be$ from Si and Mg; and of $^{7}Be$ from C and O were measured for incident protons of energies between 130 and 400 Mev to assist in the interpretation of data on cosmic-ray-produced nuclides in iron and stone meteorites. Formation cross sections of $^{54}Mn$, $^{52}Mn$, $^{51}Cr$, $^{48}V$, and $^{32}P$ were found to be a factor of 2 to 3 lower from Ni than from Fe, whereas those of $^{56}Co$ were 20- to 50-fold higher than from Fe. $^{7}Be$ cross sections from C were found to be almost the same as from O, within experimental uncertainties. Cross sections of $^{24}Na$ and $^{22}Na$ from Mg and Si were found to be relatively energy independent, whereas those of $^{32}P$ and $^{7}Be$ from Ni and Fe were found to increase rapidly with increasing energy. Some qualitative conclusions are drawn about the production of cosmogenic activities in meteorites. (auth)

**22882** GRAPHICAL RESOLVING OF GAMMA SPECTRA. Naomi A. Hallden and J. H. Harley (Atomic Energy Commission, New York). Health Phys., 10: 265-9(Apr. 1964).

A graphical technique for resolving gamma spectra of low activity samples is described. It offers advantages in terms of counting statistics, accuracy and simplicity and is particularly applicable to the results of whole-body counting and milk analysis. It is possible that it will lend itself to computer operation but at present the advantage of the graphical method is that it is more accurate and less laborious than existing stripping methods. (auth)

**22883** ON THE BINDING ENERGIES OF THE MOST STRONGLY BOUND NUCLEI OF DIFFERENT MASS NUMBERS. A. K. Dutta, B. Pal, P. Ganguly, and D. Banerjee (University Coll. of Science, Calcutta). Indian J. Phys., 37: 543-5(Oct. 1963).

A previously reported equation for nuclear binding energies in terms of mass number was modified, and a formula representing the neutron-proton ratio as a linear function of mass number was presented. (C.E.S.)

**22884** NEUTRON CROSS-SECTIONS OF SODIUM AND COPPER IN THE ENERGY RANGE 0.001–0.05 ev. Feroz Ahmed and Sudhir K. Trikha (Univ. of Delhi). Indian J. Pure Appl. Phys., 2: 135-7(1964).

Total cross sections for sodium (body-centered cubic lattice) and copper, which crystallizes in a face-centered cubic lattice, at 300°K were calculated, using the Debye model for lattice vibrations. The one-phonon inelastic scattering cross section ($\sigma_{1,\,inc}$) was calculated for both cases on the incoherent approximation. For copper, because of its large mass, it is possible to use the Placzek expansion in the energy range $0.001 \text{ ev} < E < 0.01 \text{ ev}$. The calculated values of the total cross section $\sigma$, which is the sum of the elastic scattering cross section $\sigma_{0,\,coh}$, inelastic scattering cross section ($\sigma_{1,\,inc}$) and absorption cross section ($\sigma_a$), are in good agreement with the experimental values for copper. (auth)

**22885** THEORETICAL CALCULATION OF N.M.R. SPECTRAL LINE SHAPES. Masuo Suzuki and Ryogo Kubo (Tokyo Univ.). Mol. Phys., 7: 201-9(1963-64).

The line shape of a multiplet proton resonance changes greatly as the rate of relaxation of a nuclear spin I to which the proton is coupled increases. In order to show that such complex line shapes are generally accessible to theoretical analysis, examples of line contours are calculated and shown graphically for I = 1, 3/2, 2, 5/2, and 3. (auth)

**22886** THE HISTORY OF THE DISCOVERY OF ARTIFICIAL ELEMENTS. F. Baumgaertner (Technische Hochschule, Munich). Naturwissenschaften, 51: 1-8(1964). (In German)

A review of the postulation and discovery of artificial elements is presented. These elements, which do not occur in nature, are prepared by reactions of elementary particles or light ions with nuclei. (60 references). (M.C.G.)

**22887** INVESTIGATION OF THE ENERGY DISTRIBUTION OF BACK-SCATTERED BETA RADIATION. Hans-Wolf Thuemmel (Institut fur Angewandte Radioaktivitat, Leipzig). Nukleonik, 6: 65-77(Mar. 1964). (In German)

The previously determined maximum energies of back-scattered beta radiation (Bagdanor 1955, Husain 1958) were smaller than the maximum energies of the primary radiation; these results are in contradiction to the theory of electron scattering. The investigations described also did not confirm this theory; the reasons for these deviations are based on the not-considered dependence of the maximum range of a radiation, and therefore also the known energy-range relation, on the measurement sensitivity for determination of the absorption curve and on the energy distribution of the investigated radiation. (tr-auth)

**22888** PERTURBED ANGULAR CORRELATIONS IN A Hf-SINGLE CRYSTAL. M. Salomon, M. Zwanziger, L. Bostroem, and T. Lindqvist (Uppsala Univ.). Phys. Letters, 9: 113-15(Apr. 1, 1964).

Time-differential and integral angular correlation measurements of the 133 to 183 kev gamma cascade of $^{181}$Hf in a Hf metal single crystal were performed. The results of anisotropy measurements by both methods yield the same value of the interaction frequency. (L.B.S.)

**22889** EMISSION OF $He^3$ AND $He^4$ FROM HEAVY NUCLIDES BOMBARDED BY 155 Mev PROTONS. H. Dubost, M. Lefort, J. Peter, and X. Tarrago (Faculte des Sciences, Paris). Phys. Letters, 9: 146-7(Apr. 1, 1964).

Energy distributions were measured for $^4$He and $^3$He emitted from Au, Bi, and Th targets bombarded by 155-Mev protons, and differential cross sections are compared. It is concluded that the main part of the emission proceeds via a direct mechanism which yields preferentially particles in the forward direction. (L.B.S.)

**22890** $O^{16}(n,d)N^{15}_{gs}$ AND $O^{16}(n,p)N^{16}$ REACTIONS AT 14.4 Mev. G. Paic, I. Slaus, and P. Tomas (Institute "Ruder Boskovic", Zagreb). Phys. Letters, 9: 147-9 (Apr. 1, 1964).

Solid $TiO_2$ and gas $CO_2$ targets were bombarded by 14.4-Mev neutrons to study the angular distributions and energy spectra for the $^{16}O(n,d)^{15}N$ and $^{16}O(n,p)^{16}N_2$ reactions. The angular distribution curves are compared with Butler curves, and total cross sections are calculated. (L.B.S.)

**22891** PROTON ANGULAR DISTRIBUTIONS FROM THE $Be^9(t,p)Be^{11}$ REACTION MEASURED AT 14 Mev TRITON ENERGY. S. Hinds and R. Middleton (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Phys. Letters, 9: 149-50(Apr. 1, 1964).

Angular distributions of protons measured from the $^9$Be(t,p)$^{11}$Be reactions leading to the ground and first excited states of $^{11}$Be are presented. For the 319-kev first excited state, good agreement is obtained with an L = 2 stripping curve, calculated from the two nucleon stripping theory of Newns. No evidence of the formation of the ground state by (t,p) stripping was found. (L.B.S.)

**22892** LIMITS ON $H^5$ PRODUCTION FROM LITHIUM. N. K. Sherman and P. Barreau (CEN, Saclay, France). Phys. Letters, 9: 151-3(Apr. 1, 1964).

Coincidence measurements of beta activity from $^5$H, produced by irradiation of natural lithium with 210-Mev bremsstrahlung, are reported. From a least squares analysis of the data for $E_\beta$ = 5.3 Mev, a line of positive slope of $2.6 \times 10^{-4}$ is obtained, thus giving no evidence for radioactive decay. Calculations based on the hypothetical exponential curve for the same data yields $\bar{\sigma}(^5H) \leq 6.7$ μb. (L.B.S.)

**22893** PROTON–NEUTRON INTERACTIONS, SPIN GAPS, AND $Mo^{93}$. N. Auerbach and I. Talmi (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 9: 153-5(Apr. 1, 1964).

The level spacings of the $g_{9/2}$ $d_{5/2}$ configuration expected in $^{93}$Mo are calculated by taking the difference of the $g_{9/2}$ proton–$d_{5/2}$ neutron interaction energies from the $^{92}$Nb spectrum. Good agreement is seen between spin gaps in the calculated $^{93}$Mo spectrum of the level positions and experimental observations. (L.B.S.)

**22894** THE SPIN OF THE 3.77 Mev LEVEL OF $Si^{30}$. P. J. M. Smulders (Rijksuniversiteit, Utrecht). Phys. Letters, 9: 155-7(Apr. 1, 1964).

Gamma transitions observed in the $^{27}Al(\alpha,p)^{30}Si$ reaction are reported, and it is shown that from the 1537- and 1264-kev transitions to the 2.23-Mev state the lower component of the 3.78 doublet is excited. The spin of the 3.77-Mev level, determined from γ angular distributions and γ-γ correlations, was found to be J = 1. An energy level diagram of the lower levels of $^{30}$Si is presented. (L.B.S.)

**22895** LINE WIDTH OF THE GROUND STATE OF $B^9$. E. Teranishi and B. Furubayashi (Electrotechnical Lab., Tokyo). Phys. Letters, 9: 157-9(Apr. 1, 1964).

The total cross section of the $^9$Be(p,n)$^9$B reaction was measured in the threshold region and the results are illustrated. The ground state and the first excited state contributions are calculated, and a theoretical fitting with the observed values yields a level width, Γ, of 540 ± 210 ev for the ground state of $^9$B. (L.B.S.)

**22896** POLARIZATION OF PROTONS SCATTERED FROM $O^{16}$. C. Manduchi, G. C. Nardelli, M. T. Russo-Manduchi, and G. Zannoni (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Phys. Letters, 9: 159-61(Apr. 1, 1964).

Experimental data on the levels of $^{17}$F, based on proton elastic scattering by $^{16}$O, are summarized, and polarization measurements of protons in p–$^{16}$O elastic scattering in the energy interval 4.27 to 4.39 Mev and scattering angles of 130° to 50° are reported. The angular dependence of the experimental polarization $\bar{P}_0(\theta)$, together with the polarization calculated from a phase shift analysis, is plotted. (L.B.S.)

**22897** (γ,p) CROSS SECTION FOR Mg, P, AND S. B. S. Ishkhanov, I. M. Kapitonov, V. G. Shevchenko, and B. A. Yur'ev (Moscow State Univ.). Phys. Letters, 9: 162-6 (Apr. 1, 1964).

Photoproton (<3 Mev) yields for magnesium, phosphorus, and sulfur obtained using bremsstrahlung from the Moscow 35-Mev betatron are tabulated. The dependence of the (γ,p) reaction yield on the maximum bremsstrahlung energy is shown, and (γ,p) cross sections calculated by the Penford-Leiss matrix method are plotted for energies at 15 to 33 Mev. (L.B.S.)

**22898** THE LEVEL STRUCTURE OF $Mo^{92}$. R. Van Lieshout, S. Monaro, G. B. Vingiani, and H. Morrinaga (Instituut voor Kernphysisch Onderzoek, Amsterdam). Phys. Letters, 9: 164-6(Apr. 1, 1964).

The decay of $^{92}Tc$ produced from deuteron bombardment of $^{92}Mo$ was studied in an effort to determine the level structure of molybdenum isotopes. The total decay energy of $^{92}Tc$ to $^{92}Mo$ was found to be 7.9 ± 0.2 Mev. The proposed decay scheme is compared with the level scheme of $^{90}Zr$ and predicted levels of $^{92}Mo$. (L.B.S.)

**22899** INELASTIC PROTON SCATTERING AT 185 Mev AND THE 7.66-Mev STATE OF CARBON 12. D. Hasselgren, P. U. Renberg, O. Sundberg, and G. Tibell (Uppsala Univ.). Phys. Letters, 9: 166-8(Apr. 1, 1964).

A typical energy spectrum showing the elastic and the first few inelastic peaks obtained at a scattering angle of 6° is presented. The angular distribution of the 7.66-Mev level of $^{12}C$ is shown down to 3°, and a rise in the cross sections at the smaller angles is seen. (L.B.S.)

**22900** ($\alpha-Be^8$) DISINTEGRATION OF THE 16.11 Mev ($2^+$) LEVEL OF $C^{12}$. J-P. Longequeue, N. Longequeue, and H. Beaumevielle (Universite, Grenoble, France). Phys. Letters, 9: 171-3(Apr. 1, 1964).

It is asked whether the decay of $^{12*}C$ (16.11 Mev) is predominantly by $\alpha + {}^8Be$ or $3\alpha$. For the reaction $^{11}B(p,\alpha)$, the energies of alphas emitted in coincidence at 180° were summed, to discriminate for the $\alpha-{}^8Be$ disintegration mode. The results for $E_p$ = 163 kev (the 16.11-Mev level) and for $E_p$ = 350 kev (outside the 16.11-Mev resonance) were compared. If it is assumed that the 2-body disintegration is predominant outside the resonance, it is found that $\alpha-{}^8Be$ disintegration is equally predominant at 163 kev. A direct disintegration to $3\alpha$ is not excluded, but merely limited to a maximum of 40% of the possible cases at the 16.11-Mev level. (M.J.T.)

**22901** BETA DECAY FROM $B^8$ TO THE 16.67 Mev LEVEL IN $Be^8$. E. Matt, H. Pfander, H. Rieseberg, and V. Soergel (Universitat, Freiburg i. B.). Phys. Letters, 9: 174-6(Apr. 1, 1964).

The break up of the 16.67-Mev $^8Be$ state into two 8.3-Mev α particles is established in measurements of the α spectrum and is confirmed by comparison of the observed spectrum with the spectrum calculated from a Breit-Wigner formula. The low ft value suggests the quantum numbers $J^\pi = 2^+$, T = 1 for the 16.67-Mev $^8Be$-state, and a width of 150-kev supports this assignment. (L.B.S.)

**22902** EXPERIMENTAL TEST FOR α—TRANSFER REACTIONS. H. R. Blieden (CERN, Geneva). Phys. Letters, 9: 176-8(Apr. 1, 1964).

It is pointed out that the Frieman-Yang tests can give a definite prediction for the exchange of spin-zero clusters ($^4He$, $^8Be$, $^{12}C$, etc.) in direct nuclear reactions. An example of a direct pickup reaction is considered, and first-order diagrams of the pickup and knockout reaction mechanisms in the non-exchange and exchange modes are presented. Other possible reactions for testing spin-zero transfer are tabulated. (L.B.S.)

**22903** STUDY OF SHELL CLOSURE EFFECT ON PROTON TOTAL REACTION CROSS SECTIONS. M. Q. Makino (Univ. of Southern California, Los Angeles), C. N. Waddell, R. M. Eisberg, and J. Hestenes. Phys. Letters, 9: 178-80(Apr. 1, 1964).

Several hypotheses have been advanced to explain the decrease in the total reaction cross section, $\sigma_R$, of nickel for medium energy protons. Anticoincidence beam attenuation technique was used in measurements of $\sigma_R$ for nickel and other nuclei near the z = 28 shell closure for 28-Mev protons. Results, shown together with other measurements, are consistent with the conclusion that $\sigma_R$ of nickel for medium energy protons are relatively low, and that there is no obvious energy dependence on the magnitude of this effect. (L.B.S.)

**22904** EFFECTIVE SHELL-MODEL INTERACTION FOR THE ISOTOPES OF OXYGEN. S. Cohen (Argonne National Lab., Ill.), R. D. Lawson, M. H. MacFarlane, and M. Soga. Phys. Letters, 9: 180-3(Apr. 1, 1964).

A determination of the eight independent two-body matrix elements for the neutron configurations $(1d_{5/2}, 2s_{1/2})^n$ by a least-squares fit to observe level energies in $^{18}O$, $^{19}O$, and $^{20}O$ is described. The energy spectra and two-body interaction matrix elements are tabulated. (L.B.S.)

**22905** THE OCCURRENCE OF $He^5$ CASTS DOUBTS ON THE STABILITY OF $H^5$, $H^4$ AND TETRANEUTRON. V. I. Goldanskii (Inst. of Chemical Physics, Moscow). Phys. Letters, 9: 184(Apr. 1, 1964).

It is argued that the occurrence of $^5He$ imposes the condition $28 < {}^{2*}E < 29$ Mev for the energy of the first excited state of an alpha particle with isotopic spin T = 2, thereby the occurrence of the tetraneutron is rejected. Other arguments show that $^4H$ is unstable towards decay into $n + {}^3H$ and $^5H$ is unstable towards decay into $2n + {}^3H$. (L.B.S.)

**22906** SLOW NEUTRON-DEUTERON CAPTURE AND THE STRUCTURE OF $^3H$ AND $^3He$. N. T. Meister, T. K. Radha, and L. I. Schiff (Stanford Univ., Calif.). Phys. Rev. Letters, 12: 509-11(May 4, 1964).

An upper limit on the rate of deuteron capture of slow neutrons is found sensitive to the size parameter in the S′-state wave function where S′ is the $^2S_{1/2}$ state of mixed symmetry with $I = \frac{1}{2}$. Calculations were performed with the Gaussian wave function. Results suggest that the S′ state is not present enough to account for the observed difference between the form factors of the like nucleon pair and odd nucleon in $^3He$ and $^3H$. Two other possible explanations of the electron scattering data are considered. (M.J.T.)

**22907** DEUTERON PRODUCTION IN PROTON-NUCLEUS COLLISIONS AT HIGH ENERGIES. Dabbiru Sankar Narayan (Tata Inst. of Fundamental Research, Bombay), and Kuruganty Veera Lakshmana Sarma. Progr. Theoret. Phys. (Kyoto), 31: 93-102(Jan. 1964).

A model for the production of deuterons and nuclei of $^3He$ and $^3H$ in high energy nuclear collisions is presented. The model is based on an interpretation of the high energy nucleon-nucleus collisions as composite collisions of the incident nucleon with a number of target nucleons rather than as a succession of individual collisions. It is assumed that the incident nucleon and the compound of struck nucleons go into excited states after such a composite collision. This hypothesis is an extension of the so called "excited nucleon model" for N-N collisions. From the decay of the excited compound of struck nucleons, bound systems of nucleons, like deuterons, are produced, in addition to pions and such other secondary particles. Calculations based on the model seem capable of explaining the observed features of the production of deuterons in 25 Bev proton collisions. (auth)

**22908** FORMAL CONSEQUENCES OF CONSERVATION OF ANGULAR MOMENTUM PROJECTIONS. M. E. Rose and M. Morita (Univ. of Virginia, Charlottesville). Progr. Theoret. Phys. (Kyoto), 31: 103-6(Jan. 1964).

The relation between the physical conservation of angular momentum projection in the emission or absorption of radiation and the existence of certain formal sum rules involving 3j and 6j symbols is discussed. The general sum rule is applied to the emission of particles of spin ≤1. The sum rule is, however, more general than the applications made and is readily applied for arbitrary spins. (auth)

**22909** MUON CAPTURE IN $He^3$. Akihiko Fujii and Yoshio Yamaguchi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 31: 107-14(Jan. 1964).

The transition rate of the particular muon capture reaction between the ground states of $^3He$ and $^3H$ is calculated in a completely relativistic fashion, in which all the structure effects are reduced to form factors. The computed capture rate agrees well with the experimental data, provided that the induced pseudoscalar term has the same sign and nearly the same magnitude as Goldberger-Treiman's result for the nucleon in the dispersion theoretic approach. (auth)

**22910** AN INVESTIGATION OF THE $S^{34}(p,\gamma)Cl^{35}$ REACTION. J. Dubois. Trans. Chalmers Univ. Technol., Gothenburg, No. 266, 1-31(1963).

The $^{34}S(p,\gamma)^{35}Cl$ reaction was studied for the 800–1400 kev. Capture gamma rays at eight resonances were measured, and a decay scheme constructed. (auth)

**22911** RADIATIVE PROTON CAPTURE IN $Ca^{44}$. J. Dubois and H. Albinsson. Trans. Chalmers Univ. Technol., Gothenburg, No. 267, 1-21(1963).

The reaction $^{44}Ca(p,\gamma)^{45}Sc$ was studied for proton energies from 800 to 1400 kev. One hundred four resonances were found. The decay properties of the low energy levels in $^{45}Sc$ were obtained from the capture gamma rays detected by NaI crystals. A new level at (0.920 ± 0.005) kev is proposed. (auth)

**22912** THE $Ca^{42}(p,\gamma)Sc^{43}$ REACTION AND THE DECAY OF $Sc^{43}$. J. Dubois and L. Broman. Trans. Chalmers Univ. Technol., Gothenburg, No. 268, 1-30(1963).

The $^{42}Ca(p,\gamma)^{43}Sc$-reaction was studied for proton energies in the range 780–1420 kev. Fifty resonances were found. The capture gamma ray spectra were investigated at 9 resonances. Six low lying levels in $^{43}Sc$ were found positively, and another 4 were proposed. The level at 150 kev turned out to be an isomeric state with a mean-life equal to 620 μs. The $\beta^+$ decay of $^{43}Sc$ was studied using coincidence techniques. (auth)

**22913** LOW ENERGY EXCITED LEVELS IN SOME VANADIUM ISOTOPES. J. Dubois. Trans. Chalmers Univ. Technol., Gothenburg, No. 269, 1-28(1963).

Low energy gamma rays from proton capture in the stable isotopes of titanium were measured. To decrease the x-ray background the targets used were prepared on thin carbon foils by electromagnetical isotope separation. New levels at 420 and 605 kev in $^{48}V$ and at 324 and 900 kev in $^{50}V$ were found. Branching ratios of the low excited levels were determined. (auth)

**22914** RECOILLESS NUCLEAR RESONANCE ABSORPTION OF GAMMA RAYS: THE MÖSSBAUER EFFECT. Emil C. Metschl. VDI (Ver. Deut. Ing.) Z., 106: 429-34 (Apr. 1964). (In German)

Termed the Mössbauer effect after the name of its discoverer, the resonance absorption of gamma rays without individual nuclear recoil is one of the most fascinating results of the physical research in recent years. The vigorous progress in development that the disclosure of the new effect promoted, especially in the USA, is still going on at the same rate. Great excitement was aroused by the experimental confirmation of the relativistic red shift in the earth's gravitational field with the aid of the Mössbauer effect. (auth)

**22915** THE NON-AXIALLY-SYMMETRIC ROTATIONAL MOTION OF THE ODD-A NUCLEI $Mg^{25}$ AND $Al^{25}$. Tsung-shyh Wu and Chin-yuen Tseng (Peking Univ.). Wu Li Hsueh Pao, 20: 104-16(Feb. 1964). (In Chinese)

The non-axially-symmetric rotational motion of the odd-A nucleus is treated under the adiabatic condition. The relationship between the nonaxial and axial rotation is pointed out. The spectra of $^{25}Mg$ and $^{25}Al$ were analysed in detail. The agreement with experiment is fair. The ground state magnetic moments and reduced E2 transition probabilities between some low-lying states are also calculated. (auth)

**22916** EFFECTS OF ANHARMONIC TERMS IN SPHERICAL NUCLEUS OSCILLATIONS. Tzung-hua Chang. Wu Li Hsueh Pao, 20: 159-63(Feb. 1964). (In Chinese)

Effects of anharmonic terms in $\beta$ and $\gamma$ representations in calculations of quadrupole surface energy vibrations, in E2 transition, probability, and in electric quadrupole moments of $2^+$, states were considered. (tr-auth)

**22917** THE INTERNAL BREMSSTRAHLUNG FROM THE $\beta$ DECAY $Y^{90}$. W. Kreische (Universität, Erlangen, Ger.). Z. Physik, 177: 274-86(1964). (In German)

The internal bremsstrahlung (IB) emitted in the $\beta$ decay of $^{90}Y$ was investigated. The spectral yield was measured, as were the angular correlation between electron and IB and the dependence of the IB on electron energy. (auth)

**22918** THE SHAPE OF THE GIANT DIPOLE RESONANCE FOR LIGHT NUCLEI. Hans-Juergen Mikeska (Max-Planck-Institut für Physik, Munich and Technische Hochschule, Munich). Z. Physik, 177: 441-50(1964).

A complete spectrum of the giant dipole resonance is calculated taking into account the finite depth of the single particle potential. The mixing of the one particle-one hole excitations because of residual interactions is treated in the time-dependent Hartree-Fock approximation. If the interaction is approximated by a separable potential a general formula can be derived, which gives the total dipole excitation cross section $\sigma(E)$ in terms of the simple shell-model cross section $\sigma_0(E)$. Numerical results are given for $^{16}O$ and $^{12}C$ by evaluating $\sigma_0(E)$ in a square well potential. (auth)

**22919** DETERMINATION OF THE NUCLEAR MOMENT OF $Ho^{165}$ FROM THE HYPERFINE STRUCTURE OF THE GROUND STATE IN THE Ho–I SPECTRUM. L. S. Goodman and K. Schluepmann (Universität, Heidelberg). Z. Physik, 178: 235-43(1964). (In German)

In an atomic beam magnetic resonance experiment, the hyperfine interaction constants A and B of the $^4I_{15/2}$-ground-state of $^{165}Ho$ were found to be A = 800,58389(50) Mc and B = –1667,997(50) Mc. Using an effective value for $\langle r^{-3}\rangle$, the magnetic moment of the $^{165}Ho$ nucleus was calculated to be $\mu = 4.1(4)\mu_n$. The quadrupole moment was determined as $Q = 2.4 \cdot 10^{-24}$ $cm^2$. (auth)

**22920** THE DECAY OF $Sr^{94}$. D. Hovestadt, P. Armbruster, and J. Eidens (Technische Hochschule, Munich). Z. Physik, 178: 226-30(1964). (In German)

Using a mass spectroscopic device we have investigated the $\beta$ decay of the short-lived fission product $^{94}Sr$. A strong 1.42-Mev $\gamma$ radiation is found to be in coincidence with an allowed $\beta$ decay of maximum energy of 2.1 Mev.

The half life of the decay is determined to be 72 ± 7 sec. (auth)

**22921** INVESTIGATION OF (d,p) AND (d,α) REACTIONS ON $B^{10}$ AND $B^{11}$. G. Breuer (Physikalische Staatsinstitut, Hamburg). Z. Physik, 178: 268-86(1964). (In German)

Reaction mechanisms, angular distributions, and cross sections of the reaction $^{10}B(d,p)^{11}B$ have been measured in the energy interval from 1.4 to 3.3 Mev deuteron energy. Measurements have shown that besides the stripping mechanism with $l_n = 1$, contributions of compound nucleus formation are not negligible. Especially at $E_d = 2.3$ Mev, $E_x(^{12}C) = 27.1$ Mev, the effect of a single resonance contributes a great deal to the cross section of the groups $p_1$ and $p_2$. Further angular distributions and yield curves between 1.4 and 3.3 Mev have been measured in the (d,α) reactions on $^{10}B$ and $^{11}B$, showing quite different behavior for both target nuclei. (auth)

**22922** CHANGES IN THE RESONANCE ABSORPTION SPECTRUM OF γ RAYS OF 23.8 kev FROM $Sn^{119}$ AT A PHASE TRANSFORMATION IN THE SYSTEM $BiFeO_3$–$Sr(Sn_{\frac{1}{2}}Mn_{\frac{1}{2}})O_3$. K. P. Mitrofanov, A. S. Viskov, G. Ya. Driker, M. V. Plotnikova, Pham Zuy Hien, Yu. N. Venevtsev, and V. S. Shpinel (Moscow State Univ. and Karpov Inst. of Physics and Chemistry, USSR). Zh. Eksperim. i Teor. Fiz., 46: 383-6(Jan. 1964). (In Russian)

For a series of solid solutions based on $BiFeO_3$ the resonance absorption of 23.8-kev γ rays from $^{119}Sn$ was measured. The source of the γ quanta was $SnO_2$ enriched in $^{119}Sn$. The source was held at room temperature but the absorber temperature was varied from −190 to 500°C. The maximum absorption (at zero velocity), $\epsilon_0$, showed a sharp drop with lowering temperature, at certain temperatures. The temperature of the "transition" rose with increasing molar percent of $BiFeO_3$ in the solutions. If extrapolated to pure $BiFeO_3$, the transition temperature tended toward 380 to 400°C, which is the temperature of the antiferromagnetic transformation. It was further shown that the sharp absorption line disappears in going from 160 to −196°C, and is replaced by a widely spread absorption. In a previous paper on similar observations on $BiFeO_3$–$SrSnO_3$ the sharp "transition" behavior was interpreted as due to an abrupt change in the probability for recoilless resonance absorption f'. It is now postulated that the "transition" is the result of the Zeeman splitting of the nuclear levels. The results can be explained if an atom of Sn is in a local magnetic field of 200,000 Oe at liquid nitrogen temperature. (TTT)

**22923** INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE MÖSSBAUER EFFECT ON IMPURITY NUCLEI OF $Fe^{57}$ IN THE CRYSTALLINE LATTICE OF Au. V. I. Nikolaev and S. S. Yakimov. Zh. Eksperim. i Teor. Fiz., 46: 389-92(Jan. 1964). (In Russian)

If nuclei of mass M′ are introduced into a crystalline lattice whose atoms are characterized by a nuclear mass, M, certain discrete frequencies are introduced into the vibrational spectrum of the solid. If the force constant is unaltered, then theory predicts that, in cubic crystals, the Mossbauer effect will depend only on the frequency distribution function and the ratio M′/M. In particular if $M'/M \ll 1$, then the effective Debye temperature will be greater than that of the pure crystal. This effect was studied using the 14.4-kev γ rays from $^{57m}Fe$ in gold, for which $M'/M = 0.29$, in the temperature range of 77 to 700°K. The absorber was a foil of stainless steel. The experimental line width was found to be 5.2 ± 0.5 times the natural line width. The absorber line was shifted toward negative velocities (at room temperature) by an amount 0.78 ± 0.05 mm/sec relative to the emitted line. The Mossbauer probability for the absorber, f′, was found to be 0.82 ± 0.09 (room temperature). By measuring ϵ as a function of effective absorber thickness, and fitting with theoretical curves, the fraction of recoilless radiation emitted, f, was found to be 0.67 ± 0.06 (room temperature). The variation of f with temperature could be fitted using the previously published work of Kagan and Iosilevskii with a Debye Θ of 160 to 170°. This implies a $\Theta_{eff}$ ~300°. (TTT)

**22924** THE ENERGY LEVELS OF THE RHODIUM-104 NUCLEUS. I. V. Estulin, L. F. Kalinkin, and A. S. Melioranskii (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 46: 807-9(Feb. 1964). (In Russian)

The energy level scheme of the odd–odd $^{104}Rh$ nucleus was determined from published data on the $^{103}Rh(n,\gamma)^{104}Rh$ reaction and the decay of the $^{104m}Rh$ isomer by analyzing the results of coincidence measurements between γ quanta, carried out by means of a scintillation spectrometer and of the γ lines in the same range, as determined by a diffraction spectrometer. The proposed scheme of $^{104}Rh$ includes 26 intensive γ transitions noted by the coincidences and 86 γ lines revealed by the diffraction spectrometer, corresponding to about one-half of the known γ quanta in the 30 to 800 kev region. The level scheme is subdivided into 4 systems interconnected by high-intensity transitions at $51.422(2^-)$, $97.114(2^+)$, $180.86(2^{(+)})$, and $215.49((2)^+)$ kev. Most of the states of the 51.422 kev level have negative parity and appear through a (d,p) reaction. About one-fifth of the transitions to the ground state pass through the 180.86 kev level. Even though the interactions between protons and neutrons in the odd–odd $^{104}Rh$ nucleus complicate the energy level system, many of them may be interpreted within the framework of the currently accepted assumptions on the excited states of the nondeformed nuclei. (TTT)

**22925** FORMATION OF MULTIPLY CHARGED PARTICLES BY THE INTERACTION OF 75- TO 350-Mev PROTONS WITH NUCLEI. M. M. Makarov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 46: 809-10(Feb. 1964). (In Russian)

The nuclear emulsion method was used to study the formation of particles and fragments with multiple charges, specifically, the fragments of Li and Be formed by the spallation of heavy nuclei. The relative probability of the emission of such multiply charged particles depends on the energy of the bombarding proton beam. Study of the energy spectra indicated that the most probable energy of the fragments is independent on the energy of the bombarding particles; rather, it depends on the energy of the disintegration event by which the particles are created. High-energy fragments, with E > 24 Mev, are formed in 50% of the cases in stars with 1 or 2 prongs; if the energy of the fragments is below 16 Mev, the contribution of such stars amounts to less than 30%. There are indications that multiply charged particles are formed preferentially at the periphery of the nucleus where the density of the nuclear material is low; therefore, they may serve as an indicator of the diffusion surface of the nucleus. (TTT)

**22926** RESIDUAL n-p INTERACTIONS IN HEAVY NUCLEI AND HIGH ISOMERIC STATES. L. A. Sliv and Yu. I. Kharitonov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 46: 811-13(Feb. 1964). (In Russian)

In many nuclear phenomena the residual n-p interaction between the nucleons of over-filled neutron and proton

shells play an important role. The theoretical analysis of the heavy nucleus $^{210}Bi$ indicated that the Wigner and the singlet force parameters, $v_0$ and $v_1$, respectively, possess the same sign (attraction) and are nearly equal in absolute value. For configurations with odd N values, levels with intermediate spin are located between the minimum and maximum values and therefore no isomerism occurs. In the range of the light nuclei, A < 100, the parameters $v_0$ and $v_1$ have opposite signs. In the transuranic region several configurations favorable to isomeric states are encountered. The isomeric level configuration, spin, and approximate excitation energy of $^{210}Bi$, $^{211}Bi$, $^{211}Po$, $^{212}Po$, $^{214}Po$, $^{214}At$, $^{216}Rn$, Ra, Th, U, Pu, and Cu are presented in tabular form. It was concluded that high isomeric states may be encountered relatively often. Determination of the lifetime of the isomeric levels allows knowledge concerning the nature of the n-p reactions in nuclei to be increased. (TTT)

**22927** ISOBARIC ANALOGUE STATES IN HEAVY NUCLEI. D. Robson, J. D. Fox, J. A. Becker, P. Richard, C. F. Moore, D. Long, S. I. Hayakawa, G. Vourvopoulos, and C. E. Watson. 41p. (CONF-481-55)

From American Physical Society Annual Meeting, New York, Jan. 1964.

The experimental existence and theoretical usefulness of analog states as compound-nucleus resonances are demonstrated. About 50 states were observed. Data on specific nuclei are included. It is concluded that every state $\phi_{TT}$ has an analog $\phi_{T,T-1}$, although the reverse is not true, because of the Pauli principle. In heavy nuclei the states $\phi_{T-1,T-1}$, $\phi_{T,T-1}$ are widely separated; this separation explains the clear appearance of analog states in proton capture experiments. These effects are harder to observe in light nuclei, as the bands overlap too much because of the smaller T-spin splitting. (auth)

## Plasma Physics and Thermonuclear Processes

**22928** (AD-435879) PROJECT SQUID. Semi-Annual Progress Report, October 1, 1963–March 31, 1964. (Virginia. Univ., Charlottesville. School of Engineering and Applied Science). Apr. 1964. Contract Nonr-3623(00). 80p.

Research progress on nonsteady and nonequilibrium flow, turbulence, shock wave separation in gas mixture, dynamics of gases and plasma, thermodynamic and transport properties of gases at high temperatures and pressures, electric phenomena in two-phase flow, chemic-ionization, fast reactions, reaction kinetics in high-temperature gases, reactions of ions and electronically excited species with atoms and molecules in the gas phase, chemical kinetics and gas dynamics of atom and free radical reactions, inelastic molecular collisions, solid propellant flame mechanisms, and magnetohydrodynamics of partially ionized gases is reported. (M.C.G.)

**22929** (AFCRL-63-907) NOTES ON HYDROMAGNETICS AND PLASMA PHYSICS. R. L. Caravallano and J. F. McClay (Air Force Cambridge Research Labs., Laurence G. Hanscom Field, Bedford, Mass.). Oct. 30, 1962. 112p.

The equations (MHD) for an electrically neutral, conducting fluid are examined, together with the Debye length of a plasma. The equations for a two-fluid-model plasma are then developed and used to obtain the equations for a one-fluid model. Propagation of hydromagnetic waves through a neutral conducting fluid, charged particle motion in certain force fields, and adiabatic invariants are also treated. (D.C.W.)

**22930** (AFOSR-64-0803) MICROWAVE INTERACTION WITH BOUNDED GYROELECTRIC PLASMAS. Technical Report No. 31. Elliott R. Nagelberg (California Inst. of Tech., Pasadena. Antenna Lab.). Apr. 1964. Contract AF49(638)-1266. 112p.

The interaction of microwaves with gyroelectric plasmas of finite extent, particularly those having cylindrical or spherical boundaries, is investigated theoretically. Within the latter class of problems, only those involving the axially magnetized column with circular cross section are amenable to rigorous analysis. It is found that one of the important effects of the anisotropy is to induce changes in the polarization of the scattered field resulting from interaction with an obliquely incident plane wave. As a means of solving problems which involve uniform but arbitrarily directed magnetization, the perturbation theory of microwave interaction in which the static magnetic field is regarded as a small perturbation of the isotropic plasma is developed. The field equations are derived for all orders; but only those of first order, linear in the magnitude of the static magnetic field, are solved. This solution is carried out in general, the only restriction being that the fields for the isotropic problem are assumed to be known. The first order theory is then applied to cylindrical and spherical problems. When the approximate solution for the axially magnetized column is compared with the exact result, agreement is obtained provided that the static magnetic field is weak, as expected. Finally, the problem of a magnetic dipole radiating from within a weakly magnetized plasma sphere is considered. (auth)

**22931** (ARL-64-14) MEASUREMENT OF FIELDS IN THE PLASMA SHEATH BY AN ELECTRON BEAM PROBING TECHNIQUE. R. Harp and G. S. Kino (Stanford Univ., Calif. Microwave Lab.). Jan. 1964. Contract AF33(616)-8121. 21p.

An experiment to measure both r-f and d-c fields in the sheath is described. The fields were determined by finding the deflection of an electron beam passed parallel to the sheath plasma interface. The sheath was formed in a low density plasma on a metal plate inserted into the plasma. Both the d-c and r-f field variations through the sheath, when an r-f potential was applied to the plate, were measured. The d-c field variation is in good agreement with a theory by Self. The measured r-f field variations are in good agreement with a theory given by Pavkovich. No self-oscillations of any kind were measured in the sheath. This is attributed to a good Maxwellian distribution of electron velocities obtained by careful design of the discharge electrodes. (auth)

**22932** (ARL-64-15) RF BEHAVIOR OF THE PLASMA SHEATH. J. Pavkovich and G. S. Kino (Stanford Univ., Calif. Microwave Lab.). Jan. 1964. Contract AF33(616)-8121. 20p.

A theoretical treatment for the variation of r-f fields within the sheath is given. The analysis is based on an integration of the collisionless Boltzmann equation, with the assumption that the static potential varies parabolically in the sheath. It is shown that an effective impedance for the sheath can be defined, and that over the range in which the numerical results were calculated, this impedance always has a real positive part. The real part of this impedance is associated with Landau damping. A set of curves is given of the field through the sheath. (auth)

**22933** (ARL-64-17) NUMERICAL CALCULATIONS RELATED TO THE RF PROPERTIES OF THE PLASMA SHEATH. J. M. Pavkovich (Stanford Univ., Calif. Microwave Lab.). Jan. 1964. Contract AF33(616)-8121. 182p.

A detailed r-f theory of the sheath is presented. The complete collisionless Boltzmann equation is used to derive a linear integral equation for the r-f electric field through the sheath. The analysis is one-dimensional. This integral equation is solved numerically for a semi-infinite uniform plasma bounded by a sheath defined by a parabolic d-c potential. A Maxwellian distribution of velocities is assumed for all computations. The results show that it is reasonable to assume that the normal component of displacement is continuous, but that extra waves are set up near the boundary which decay with depth into the uniform plasma. These waves are somewhat like the cutoff waves excited in the neighborhood of a waveguide discontinuity and give rise to a sheath impedance. If the plasma is treated as a dielectric, this impedance gives rise to a small discontinuity in the tangential component of electric field. In many cases this discontinuity is negligible. However, the impedance does contain a resistive component corresponding to Landau damping, which is quite important in the consideration of loss. In none of the computations has this resistive component become negative for a Maxwellian distribution leading to a prediction of no oscillations in the sheath. The results further show that for frequencies below the plasma frequency, the field reverses from inside to outside as expected. However, the magnitude does not become particularly large in the region where $\omega = \omega_p$. A pressure-type theory is also presented. This theory is based on moments of the collisionless Boltzmann equation. The results do not agree very well with results of the more exact theory, and it is concluded that this type of theory is rather unreliable. (auth)

**22934** (ARL-64-24) INTERACTION OF RADIATION AND MATTER IN A PLASMA. Ludwig Oster (Yale Univ., New Haven. Observatory). Feb. 1964. Contract AF33 (616)-7271. 18p. (AD-432824)

The present state of the investigations carried out at the Yale Observatory on interactions between radiation and matter in a plasma is summarized. In particular, results based on a new transfer equation of radiation in dispersive media, and a discussion of some practically interesting cases of departures from local thermodynamic equilibrium in continuous energy states are given. (auth)

**22935** (ARL-64-44(Pt.I)) STATISTICAL PLASMA THEORY II. PART I. THE DIELECTRIC CONSTANT OF A PLASMA. G. Kalman (Paris. Université, Orsay. Ecole Normale Superieure. Faculté des Sciences). 1963. Contract AF61(052)-613. 59p.

The dielectric constant and its relation to the permeability are defined, and the properties of the dielectric tensor are discussed. A relation between the dielectric constant and the dynamical correlation function of a system is established, and the dielectric constant is then calculated under the assumption of weak coupling between particles of the system. The dielectric constant of a two-component system is also examined, as is the dielectric tensor for certain situations. (D.C.W.)

**22936** (ARL-64-45) LONGITUDINAL DIELECTRIC CONSTANT OF A FULLY IONIZED PLASMA. Technical Note No. 6. J. Coste (Paris. Université, Orsay). Nov. 15, 1963. Contract AF61(052)-613. 63p.

The dielectric constant $\epsilon(k,\omega)$ of a plasma is derived, starting from the kinetic equations of Guernsey and using a high-frequency approximation. The effects of the correlations between the particles are included up to the first order in the plasma expansion parameter. Some limiting cases and physical applications are considered. Equilibrium quantities are obtained from $\epsilon(k,0)$. (auth)

**22937** (GNE/PHYS/63-13) INVESTIGATION OF PLASMA POTENTIAL DETERMINATIONS UNDER CONDITIONS OF SPUTTERING (thesis). Jerry Lee McKenzie (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). May 1963. 187p. (AD-418564)

The potential of an Ar plasma in a discharge chamber with sputtering due to Ar ions incident on a Au target was measured, and the effect of various parameters on the potential was studied. Normally incident ions were obtained by placing a Cu guard ring around the single-crystal Au target. Sputtering was observed by a spectrometric method, and the potential was measured with a small spherical W probe. The plasma potential was determined to be 15.5 v in the region of the Au target, and the potential was determined to be uniform across the target, guard ring, and discharge chamber. The theoretical background for the experiment is presented, and the experimental apparatus and procedures are described. (D.C.W.)

**22938** (IPPJ-22) ENERGY LOSS OF AN ELECTRON BEAM IN A PLASMA. J. Uramoto (Nagoya, Japan. Univ. Inst. of Plasma Physics). Feb. 1964. 30p.

Energy loss of an initially uniform 1.1 kev electron beam being injected into a plasma is studied with an electrostatic energy analyzer. The plasma is produced by the electron beam itself or by a gas discharge. The dependences of the energy loss on the pressure in the plasma region, on the intensity of the electron beam current, on the beam-plasma interaction length and on the intensity of the gas discharge current is determined experimentally. The total energy loss per electron of the beam amounts to 100 ev for a plasma density of $5 \times 10^9$ cm$^{-3}$ and a beam current of 4 mamp. The bunching process of the electron beam interacting with the plasma is analyzed on the basis of linear theory as well as non-linear theory. The energy loss can semi-quantitatively be explained by taking account of the coherent interaction between electron beam and plasma. A theory of the latter process which is generalized to treat a series of bunched electrons is discussed. (auth)

**22939** (IPPJ-24) THE KINETIC THEORY OF STABLE PLASMAS. Ta-You Wu (Nagoya, Japan. Univ. Inst. of Plasma Physics). Mar. 1964. 27p.

The Boltzmann and Bogoliubov theories for neutral gases are briefly reviewed and evaluated, together with the master equation for irreversible processes. The Boltzmann, Fokker-Planck, and Vlasov kinetic equations for plasmas are then treated similarly; and two more general kinetic theories for plasmas are discussed. (D.C.W.)

**22940** (JPL-TR-32-553) DAMPING OF QUANTIZED LONGITUDINAL PLASMA OSCILLATIONS. E. H. Klevans, P. B. Burt, and C.-S. Wu (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Apr. 15, 1964. Contract NAS-7-100. 15p.

Although the damping of longitudinal plasma oscillations has received considerable study for both classical plasmas and degenerate electron gases, expressions for damping in the degenerate systems at arbitrary temperatures were not obtained. The damping in the degenerate electron gas at arbitrary temperatures is evaluated within the random phase approximation (RPA) in the long-wavelength limit. In addition, exchange damping for a plasma slightly above the degeneracy temperature is evaluated and is shown to be comparable to the RPA damping for a wide range of parameters. (auth)

**22941** (MATT-195) A NEW SOLUTION OF THE KINETIC EQUATIONS FOR A PLASMA INCLUDING RADIATION. Ronald L. Fante (Princeton Univ., N. J. Plasma Physics Lab.). Oct. 1963. Contract AT(30-1)-1238. 146p.

The Fokker-Planck equation and the rate of energy transfer from the particles to radiation field in an infinite, spatially homogeneous plasma, with and without an applied external magnetic field, are obtained. For a plasma with no external fields it is found that there is no energy transfer from particles to the radiation field for scales of order of the time between collisions. However, if an external magnetic field is applied, a strong interchange of energy due to cyclotron and synchrotron effects is found. The emission and absorption coefficients for these processes are obtained. The behavior of the induction fields in the plasma is examined. It is found that they approach their asymptotic values in times of order of a plasma oscillation (i.e. times of order $\omega p^{-1}$, where $\omega p$ is the electron plasma frequency). (auth)

**22942** (MATT-242) EXCITATION OF ELECTROSTATIC OSCILLATIONS IN A MAGNETIC FIELD. Francis F. Chen (Princeton Univ., N. J. Plasma Physics Lab.). Jan. 1963. Contract AT(30-1)-1238. 106p.

Results of the cold-plasma approach to the theoretical treatment of the problem of electrostatic instability excited by electron beams are assembled. The general dispersion relation and the electrostatic approximation are derived. Waves in a static plasma are described. It is proved that only slow waves cause instabilities. Convective and absolute instabilities and Galilean invariance are discussed. A new calculation of the growth rates of electrostatic interactions for zero temperature is presented and compared with results of Stepanov and Kitsanko. (M.J.T.)

**22943** (MATT-243) A SOLUTION OF THE KINETIC EQUATIONS FOR A PLASMA INCLUDING RADIATION IN THE PRESENCE OF AN EXTERNAL MAGNETIC FIELD. Ronald Fante (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 1963. Contract AT(30-1)-1238. 32p.

The solutions of the Simon-Harris hiearchy of equations are obtained and used to derive an equation of radiative transfer for a spatially homogeneous plasma in a constant magnetic field. It is found that observation on a time scale of the order of the time between collisions shows that there is a net radiative transfer occurring. The limiting case of zero magnetic field is also examined. It is then found that the radiative transfer no longer occurs on the collisional time scale, but on some longer scale. (auth)

**22944** (MATT-256) AN AXIALLY SYMMETRIC MINIMUM B CONFIGURATION. George V. Sheffield (Princeton Univ., N. J. Plasma Physics Lab.). Apr. 1964. Contract AT(30-1)-1238. 22p.

An arrangement that provides a magnetic field configuration (magnetic well) containing a finite volume in which the absolute value of the magnetic field strength has a non-zero minimum was determined by computer calculations. A substantial mirror ratio can be achieved with the system. Field plots and coil arrangements are shown. (D.C.W.)

**22945** (NP-13798) COMPRESSIBLE PLASMA FLOW OVER A BIASED BODY. C. H. Su (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). Mar. 1964. 38p.

The flow field of a compressible plasma over a biased body is analyzed with emphasis on the electrical characteristics. The governing equations is various asymptotic regions are investigated. A stagnation point probe theory is given in detail. An analytic current-voltage characteristic is obtained for this case under the assumption of a very thin electrical sheath. (auth)

**22946** (ORNL-3591(p.241-8)) CHEMICAL SUPPORT FOR THE CONTROLLED THERMONUCLEAR PROGRAM. J. D. Redman, D. M. Richardson, and R. A. Strehlow (Oak Ridge National Lab., Tenn.).

Improvements in vacuum technology were achieved as a result of several research efforts. Use of a time-of-flight mass spectrometer permitted the analysis of organic fragments from various commercially available vacuum pump oils and changes in the specifications for oils to be used in the forepumps and roughing pumps in large thermonuclear test systems. Very high compression ratios for hydrogen were measured by the use of two diffusion pumps in series; it appeared possible to reach lower ultimate pressures by the series technique. Adsorption and desorption of contaminant gases from metal surfaces at liquid nitrogen temperatures and under conditions of low fractional surface coverage were studied, and the heats of desorption were measured in an ultrahigh-vacuum facility having a test volume of almost 300 liters; knowledge of these heats permits more effective removal of the contaminant gases via a temperature cycling process. Acceptance tests for high-vacuum valves were developed, and a metallurgical basis for the selection of bakeable flange-gasket combinations was discovered. Studies of the behavior of high-vacuum ionization gages led to diagnostic procedures for determining whether a particular gage is operating reliably. Suspicion was focused on thoriated iridium filaments as the source of previously unexplained amounts of $CO_2$ as a residual gas in ultrahigh vacuum systems; reaction of the filament with organic contaminant gases is believed to give rise to the $CO_2$. Synthetic samples of $\beta$-eucryptite ($LiAlSiO_4$) were obtained and were studied as sources of lithium ions at high temperature. (auth)

**22947** (PAN-472/XVIII) TRIGGERED VACUUM SWITCH FOR PLASMA RESEARCH DEVICES. Marek Sadowski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Nov. 1963. 12p.

The main problems accompanying the design and construction of triggered vacuum spark gaps are discussed. A high-power vacuum spark gap is described which is capable of switching high pulse currents of the order of $10^6$ amp. The operating voltage range of this switch is sufficiently large (2 to 50 kv). Due to the use of slit-shaped triggering holes, the time delay to breakdown of the main discharge is practically independent of applied d-c voltage. (auth)

**22948** (PIBMRI-1056-62) FUNDAMENTAL STUDIES IN THE MICROWAVE PROBING OF MEDIUM AND HIGH-DENSITY PLASMAS. Final Report. M. Ettenberg (Brooklyn. Polytechnic Inst. Microwave Research Inst.). July 26, 1962. Contract AF19(604)-8070. 11p. (AFCRL-62-895; AD-417338)

A method is presented for determining the electron density profile of a plasma that varies in one direction by measuring the phase of a microwave signal reflected from the plasma. The method was applied to a pulsed hydrogen discharge. (D.C.W.)

**22949** (RADC-TDR-63-240) NONLINEAR INTERACTION OF A HIGH-INTENSITY MICROWAVE FIELD WITH A LOW-DENSITY PLASMA. Fedele J. Sforza (Rome Air

Development Center, Griffiss AFB, N. Y.). Aug. 1963. 59p. (AD-419395)

The interaction of a high-intensity electromagnetic field of a fundamental microwave frequency with a low-density plasma slab in an infinitely-long rectangular waveguide was studied. The current density distribution induced in the plasma by the high-intensity field was obtained by solving the Boltzmann transport equation, together with the Maxwell equations. General expressions for the fields generated in a rectangular waveguide by an arbitrary current distribution are presented from which expressions for the $TM_{mn}$ and $TE_{mn}$ modes generated by the second harmonic component of the induced current distribution are obtained. Detailed computations of the power generated in the $TE_{11}$ and $TM_{11}$ modes as a function of the plasma frequency for particular thicknesses of the plasma slab are presented in graphical form. Curves of the reflected power of the high intensity field from the plasma slab are also presented and compared with the second harmonic $TE_{11}$ and $TM_{11}$ power curves, from which a number of interesting results are derived. (auth)

**22950** (RISÖ-74) A DOUBLE LINE-SPLITTER FOR MEASUREMENT OF TIME VARIATION OF SPECTRAL-LINE PROFILES IN PLASMA PHYSICS. V. O. Jensen (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Jan. 1964. 8p.

A line-splitter (polychromator) built for use in connection with the SPM 2 Jena monochromator is described. The line-splitter can be employed for the measurement of time-dependent spectral-line profiles. It has two sets of seven channels, which measure the light intensity at seven different wave lengths simultaneously as a function of time. The two sets of channels measure the same spectral-line profile simultaneously. The instrument can therefore be used for comparing profiles of the same spectral line emitted in two different directions from a plasma or emitted from two different places in a plasma. It may also be used for comparing the profiles of a spectral line which has passed polarization filters with two different orientations. The distance in Å between the channels is variable down to 4 Å between the outermost channels. Each channel takes light from a wavelength region variable down to 0.55 Å. (auth)

**22951** (RM-3755-PR) PLASMA CONDUCTIVITY AT LOW FREQUENCIES AND WAVE NUMBERS. M. G. Kivelson and D. F. DuBois (RAND Corp., Santa Monica, Calif.). Apr. 1964. Contract AF49(638)-700. 44p.

The low frequency electromagnetic conductivity of high temperature, low density plasmas is examined starting from a linearized kinetic equation of the Balescu type. The equation is solved in the limits $\omega \gg \Gamma_{ee}$ and $\Gamma_{ii} \gg \omega$, where $\Gamma_{ee}$ and $\Gamma_{ii}$ are the inverses of the equipartition times of electrons and ions, respectively. The conductivity is related in a well-known way to the properties of collective waves, and expressions are obtained for the phase velocity and damping of these waves. The results agree with experiment to just within experimental accuracy. (auth)

**22952** ON THE STRUCTURE OF THE SLOW SHOCK IN A NONDISSIPATIVE SYSTEM OF TWO FLUIDS. Roger Peyret (Institut H. Poincare, Paris). Compt. Rend., 258: 2973-6(Mar. 16, 1964). (In French)

The structure of the slow shock is investigated for the case in which the two fluids (electrons and ions) do not exert dissipative forces upon each other. (D.C.W.)

**22953** DYNAMICAL PROPERTIES OF PROBE IN GAS DISCHARGE PLASMA. Takami Okuda (Nagoya Univ., Japan). Denki Gakkai Zasshi, 83: 1922-30(Nov. 1963). (In Japanese)

In most discharge plasmas, the electrical conduction is influenced by space-charge phenomena. Therefore, it is worthwhile to study the behavior of space-charge sheaths. Due to an increased interest in studying transient plasma, exact information on the dynamic properties of space-charge sheaths is needed. It is convenient for this purpose to make use of the space-charge sheath developed around a probe immersed in plasma. The type of sheath to be studied can be easily chosen by adjusting the potential difference between the probe and the plasma. In this way it is possible to realize negative and positive space-charge sheaths. This voltage difference is suddenly changed and the current response is measured. By varying the fixed bias potential and the amplitude of the voltage change, the dynamic behavior of each type of sheath and the phenomena due to transitions between them can be studied. In order to avoid the influence of stray capacitances on the measurement, several precautions in the design of the measuring circuit are taken. Moreover, it is necessary to use a specially constructed shielded probe. The dynamic probe current shows delay phenomena, which are very pronounced for probe voltages close to plasma potential. This effect is studied by the pulse probe method and the high-frequency probe method. Since the delay times involved are much larger than electron sheath-transit times, the effect of ion motion on the re-establishment of the probe sheath is considered. An asymmetrical property is observed by the pulse probe method, showing a difference in the delay time when positive or negative pulses are applied. The disturbed potential distribution arising from an excess or deficient ionic space charge near the sheath could account for the asymmetrical behavior. When changing the plasma properties, it is found that the influence of delay phenomena on the probe-current collection decreases with increasing plasma density and with increasing values of the ion mobility. At highly negative probe potentials, the influence of the probe sheath capacitance was found to be very pronounced. (Nucl. Sci. Abstr. of Japan, 3: No. 2(Apr. 1964))

**22954** STUDY OF TRANSIENT SPACE CHARGE IN GAS DISCHARGE PLASMA. Takami Okuda (Nagoya Univ.). Denki Gakkai Zasshi, 83: 1931-9(Nov. 1963). (In Japanese)

An extensive study of the dynamical behavior of a space-charge sheath in a gas-discharge plasma is reported. Attention is directed towards the pulse-probe characteristics influenced by the delay phenomena investigated earlier. Also, the capacitance of the space-charge sheath is estimated by the pulse-probe method and the resonance method, and results are compared with those from the theory proposed. It is observed that the discrepancy between the static probe curve and the pulse probe curve can be significant in the neighborhood of the plasma potential and that for increasing current or decreasing gas pressure this deviation almost disappears. It is also observed that when the pulse applied to the probe excites discharge oscillations large deviations between them can appear. A modulation of discharge due to the applied pulse results in minor influence on the shape of the probe curve if the sign of the pulse is positive. However, if the sign is negative, the probe curve is appreciably distorted in spite of the smallness of the modulation. The results of pulse-probe and resonance probe methods of studying sheath capacitance are consistent and show the dependence of the sheath capacitance on plasma density and potential difference between the probe and the plasma. For instance, it is found that for increasing plasma density as well as for decreasing voltage

across the sheath, the value of the capacitance increases as can be expected from the dependence of the sheath thickness on these parameters. Expressions for the effective capacitance of the positive space charge sheath for a highly negative probe are derived for the cases of no collisions inside the sheath and of many collisions inside the sheath. The effective sheath capacitance differs from the static one due to the change of the sheath thickness as a consequence of the change in potential across the sheath. This edge motion is taken into account. By integrating the current spike due to a probe voltage pulse, the value of the sheath capacitance is determined experimentally. The values measured in this way agree surprisingly well with those obtained from the theoretical formulas, provided a shielded probe configuration is used. Expressions for the probe sheath displacement current due to a change in plasma density are derived, based on the assumption that it results from the change of the sheath thickness. Experimental verification is made by a pulse-modulated discharge. (Nucl. Sci. Abstr. of Japan, 3: No. 2 (Apr. 1964))

**22955** RECOVERY OF SPACE CHARGE SHEATH IN GAS DISCHARGE PLASMA. Takami Okuda (Nagoya Univ., Japan). Denki Gakkai Zasshi, 83: 1940-6(Nov. 1963). (In Japanese)

One of the most important conclusions drawn from the previous paper is that the change in the collection of charge carriers by a probe, due to a change in probe potential, shows in general a delay effect whose magnitude was found to depend on the potential difference between the probe and the plasma, the direction of the voltage change, the plasma density, the type of gas in which the plasma is produced, and the gas pressure. Gas discharge itself has space charge sheaths that differ slightly from the probe sheath in the existence of secondary effects. It was found from the measurement of pulse-modulated discharge that there is a similarity between their responses. The dynamical property for both cases is understood from the same point of view that the response is determined by the re-establishing process. A qualitative theory for explaining the transient space charge sheath is presented with these simplifying assumptions: (a) the electron follows the change in the probe voltage instantaneously; (b) the ion initially does not follow the change. This means that it is assumed that the delay in the re-establishment of the space charge distribution is determined by the relatively slow motion of the ions. The transient potential distributions within the sheath are constructed by considering the excess or deficient space charge resulting in a gradient of the electric field. The shape of the potential distribution depends on the initial and final states and determines the probe current response, because the probe current is a function of the potential difference between the plasma and the probe. Thus, the asymmetrical property observed in a different direction of the transition can be interpreted with this theory. An expression for the re-establishment time associated with a density perturbation is derived with the help of the quasi-steady approach, and with the assumption that the re-establishment time is determined by the motion of the ions only. Especially when the diffusion is neglected, the disturbance propagates with the ion drift velocity due to the exisisting steady electric field and decays exponentially in magnitude with the time constant, which is inversely proportional to the plasma density and the mobility of the ion. The other processes leading to the delay are the motion of ions from the initial edge to the final edge through thermal motion, or the drift due to electric field and the diffusion (free or ambipolar). The drift including the diffusion and the recovery through space charge relaxation seem to be possible processes, depending on the condition. (Nucl. Sci. Abstr. of Japan, 3: No. 2 (Apr. 1964))

**22956** THE INSTABILITY OF MAGNETOHYDRODYNAMIC, ALFVÉN WAVES OF LARGE AMPLITUDE. A. A. Galeev and V. N. Oraevskii (Novosiberian State Univ., SSR). Dokl. Akad. Nauk SSSR, 154: 1069-71(Feb. 11, 1964). (In Russian)

An Alfvén wave of small amplitude ($\delta v \ll v_a$, where $\delta v$ is the amplitude of the hydrodynamic velocity of the Alfvén wave, and $v_a$ is the Alfvén velocity) is unstable in a compressible medium because of a positive coupling between small perturbations of the Alfvén and magneto-acoustical type. This mechanism should also lead to the instability of an Alfvén wave of large amplitude. Because of the mathematical difficulties, the problem was not solved for an arbitrary profile of the initial Alfvén wave, but was limited to an Alfvén wave with a saw-toothed profile of the magnetic force lines. Perturbations of the velocity $\underline{v}$, of the magnetic field $\underline{h}$ and of the density $\rho_1$ can be presented in the form: $\psi = u(r) \exp(ipr - i\omega t)$. Here $\psi$ is $\underline{v}$, $\underline{h}$ or $\rho_1$; $u(r)$ is a periodic (with a period of the initial Alfvén wave) solution of the equations, and $\omega$ is the frequency of the perturbations. The x axis was taken in the direction of the unperturbed magnetic field $H_0$, and the y axis was taken in the direction of the oscillations of the hydrodynamic velocity $\delta v$ of the Alfvén wave, which propagates along $H_0$. An expression was derived for a wave of large amplitude ($\delta v \gg v_a$), propagating in a medium of low pressure ($c_s \ll v_a \ll \delta v_a$, where $c_s$ is the velocity of sound). This instability was similar to the instability of an Alfvén wave of small amplitude with respect to the simultaneous excitation of a slow and a fast magneto-acoustical wave. (TTT)

**22957** ION DISTRIBUTIONS IN A PULSED TOWNSEND DISCHARGE. D. Edelson, J. A. Morrison, and K. B. McAee, Jr. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 35: 1682-90(June 1964).

The equations for the pulsed Townsend discharge involving two ions interacting through the $\gamma$ process were solved for the ion densities as a function of time and position. The same mathematical approach yields equations for the single ion case, with or without diffusion, which are valid for all time. Negative ions are a special case in which $\gamma = 0$. Plots are presented of the rate of ion arrival at the electrode and of ion current, both of which are experimentally accessible. The temporal increase of ion flux in the neighborhood of Townsend's breakdown condition is shown. (auth)

**22958** ELECTRICAL CONDUCTIVITY OF POTASSIUM-SEEDED ARGON PLASMAS NEAR THERMAL EQUILIBRIUM. L. P. Harris (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 35: 1993-4(June 1964).

A series of measurements were made of the electric conductivity of atmospheric argon seeded with 0.05- to 5.0-mole potassium vapor in the 1500 to 2000°K temperature range. (C.E.S.)

**22959** ON THE MOVEMENT OF POSITIVE IONS THROUGH THE POSITIVE SPACE-CHARGE SHEATH. G. Ciobanu and Iovitzu Popescu (Inst. of Physics, Bucharest). J. Electron. Control (1), 16: 59-64(Jan. 1964).

A kinetic analysis of the movement of positive ions through the positive space-charge sheath is given for plane, cylindrical, and spherical geometries. Expressions are derived for the positive ion relaxation time, concentration, drift velocity, mean kinetic energy, and electric field in the sheath. (auth)

**22960** IMAGE CONVERTER MEASUREMENTS ON MOVING STRIATIONS. P. Bletzinger and A. Garscadden (Wright-Air Medical Center, Wright-Patterson AFB, Ohio). J. Electron. Control (1), 16: 169-73(Feb. 1964).

The method and some results of image converter measurements on striations in a neon hot-cathode discharge are presented. The structure of the striations and the importance of metastable atoms are indicated. (auth)

**22961** ON THE STRUCTURE OF A FRESH PLASMA SURFACE. Koji Fushimia and Nobuo Yajima (Nagoya Univ., Japan). Kakuyugo-Kenkyu, 10: 442-62(June 1963). (In Japanese)

On the basis of a simple soluble model, the structure of a fresh plasma surface is studied. The treatment is restricted to a collisionless plasma confined by a magnetic field, and it is assumed for simplicity that the velocity distribution within the plasma is of the form $n(u,v,w) = n_0 u_0 \delta(u^2 - u_0^2)\ \delta(v)\ \delta(w)$, where u, v, and w are respectively the x, y, and z components of the velocity of a plasma particle. The charge and current densities are defined by superposing various particle orbits. A set of self-consistent equations are derived for the electromagnetic potentials. The equations are solved analytically in a reasonable approximation for the case of neutral confinement, and the physical implications of the solution are discussed. The derived electrostatic potential is oscillatory with an amplitude $\varphi_0$ in the inner part of the plasma, and approaches a constant $\varphi_B$ near the surface. The ratio $\varphi_0/\varphi_B$ increases with ion energy. There exists, however, a certain upper limit, which has the same order of magnitude as $(u_i^2/c^2)^{1/4}$. On the other hand, $\varphi_0$ is proportional to $(u_e^2/c^2)^{1/4}\ \tau^{-1}$, where $\tau$ is defined by $\tau \equiv mu_e^2/Mu_i^2$ and represents the temperature ratio. When $\tau \to \infty$, i.e., in the limit of large electron energy, both $\varphi_0/\varphi_B$ and $\varphi_0$ decrease with electron energy, $\varphi_0/\varphi_B$ being proportional to $(u_i^2/c^2\tau)$ and $\varphi_0$ to $(u_e^2/c^2\tau)^{1/4}\ \tau^{-1}$. Thus, in this case, there exists practically an electrostatic potential within the plasma. The solution shows that the magnetic field influences the motions of electrons and ions in different manners. The electrons move and return, reversing their momenta almost solely under the influence of the magnetic field. In contrast to this, the effect of the magnetic field is rather small for the ions, and they are turned back mainly by the space charge due to the motion of electrons as a whole. Finally, the effects of the surface charge are examined. It is found that the variation of the potential on the plasma surface changes by a large amount the phase of the periodic potential within the plasma, indicating that the surface brings about effects in the inner part of the plasma. It is suggested that results may be derived, similar to those of the article, even if one starts with the Maxwellian distribution, provided that the plasma is a collisionless one. (Nucl. Sci. Abstr. of Japan, 3: No. 2 (Apr. 1964))

**22962** MICROWAVE RADIATION FROM A LONGITUDINALLY MAGNETIZED CYLINDRICAL PLASMA. Noboru Shimomura and Kenji Mitani (Kyoto Univ.). Kakuyugo-Kenkyu, 11: No. 1, 11-20(July 1963). (In Japanese)

The conversion of plasma oscillation to radiation for a cylindrical plasma in an externally applied axial magnetic field is discussed. It is assumed that the spatial distributions of electrons and ions are uniform and the ion mass is infinite. The thermal motion of electrons is neglected. Linearized equations are solved in the plasma and in vacuum for the wave whose wave vector lies in the plane perpendicular to the axis. Solutions are connected by appropriate boundary conditions. Results indicate no coupling between the component with its electric field parallel to the axis and the other two components with their electric field perpendicular to the axis. The former is not affected by the magnetic field. Its frequency is the plasma frequency plus a small term that depends on the plasma radius. This component can be radiated in any direction perpendicular to the magnetic field. The latter two components are coupled through the magnetic field. The frequency of the coupled mode is the hybrid frequency for unbounded plasma minus a small term that is a function of the plasma radius, two plasma frequencies, and electron cyclotron frequency. The radiation of this coupled mode decreases rapidly as the direction of propagation approaches the radial direction, and disappears when the direction of propagation coincides with the radial direction. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**22963** MEASUREMENT OF MICROWAVE RADIATION FROM A PLASMA IN MAGNETIC FIELD. Hiroshi Kubo (Kyoto Univ.) and Shigetoshi Tanaka. Kakuyugo-Kenkyu, 11: No. 1, 58-74(July 1963). (In Japanese)

The results of measurement of microwave radiation from a d-c discharge are described. A hot cathode discharge tube parallel to the external magnetic field was inserted into a square wave guide placed at right angles to the magnetic field. The radiation of the wave whose electric field was parallel to the magnetic field was measured by a radiometer operating in the range of 10 Gc/band. The gases used were neon, argon, krypton, and xenon. By varying the magnetic field, the harmonics with frequencies near the frequencies of the harmonics of the electron cyclotron frequencies were observed. This means that the ordinary component of a wave propagating across the magnetic field has resonances at such frequencies. The characteristics of these harmonics are as follows: (1) no cyclotron resonances are observed; (2) the number of harmonics increases as the discharge current is increased until it reaches a maximum $N_{max}$; (3) each harmonic has almost the same magnitude of radiation intensity; (4) the lower the gas pressure, the greater the $N_{max}$; (5) for the same gas pressure, the magnitudes of $N_{max}$ are in the order of Ne, Ar, Kr, Xe; (6) a fine structure is observed on the second harmonic when the gas pressure is sufficiently low; and (7) each harmonic appears at slightly lower frequencies than those of the electron cyclotron harmonics with the corresponding frequencies. These characteristics are very similar to those for the extraordinary wave. The dispersion relation is discussed for the ordinary wave. Taking the thermal motion of electrons into consideration, the refraction index for the ordinary wave is influenced by the magnetic field, and resonances occur near the electron cyclotron frequency harmonics. This may explain the experimental results. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**22964** A FLOATING TRIPLE PROBE METHOD FOR MEASURING INSTANTANEOUS VALUES OF PARAMETERS IN TIME VARYING PLASMAS. Sin-li Chen (Tokyo Univ.). Kakuyugo-Kenkyu, 12: 35-50(Jan. 1964). (In Japanese)

A new type of electrostatic probe was developed for measuring instantaneous parameters in time-varying plasmas. One common feature of all types of electrostatic probes developed so far, such as the Langmuir single and double probes and the high-frequency resonance probe, is that they always need the sweep of the probe voltage or frequency to obtain the probe characteristics from which plasma parameters are deduced. This implies that it takes a certain time for the determination of plasma parameters and it is not applicable in a strict sense for the diagnosis of the rapidly changing plasma phenomena. (Nucl. Sci. Abstr. of Japan, 3: No. 2 (Apr. 1964))

**22965** EXCITATION LEVEL OF PLASMA OSCILLATIONS. M. Feix (Institut für Plasmaphysik, Garching, Ger.). Phys. Letters, 9: 123-5(Apr. 1, 1964).

The excitation level of waves corresponding to Landau and other poles introduced by both the plasma and initial perturbation is treated. Results on the problems of free oscillations, forced oscillations, and damping of the transient cloud around an initially correlationless test particle are presented. (L.B.S.)

**22966** INTERACTION OF CHARGED PARTICLES WITH A TURBULENT PLASMA. I. A. Akhiezer (Khar'kov Inst. of Physics and Tech.). Phys. Letters, 9: 144-5 (Apr. 1, 1964).

The energy loss per unit time, P, of a charged particle moving through a turbulent plasma is evaluated. An explicit expression for the dependence of P on the velocity of the particle is found. (L.B.S.)

**22967** STUDIES OF THE MECHANISM OF ELECTRON-ION RECOMBINATION. [PART] II. William A. Rogers and Manfred A. Biondi (Westinghouse Electric Corp., Pittsburgh). Phys. Rev., 134: A1215-25(June 1, 1964).

Microwave, optical spectrometric, and interferometric techniques were used to investigate the nature of the electron-ion recombination process in low-pressure, pure helium afterglows at 300 and 77°K. To determine whether dissociative capture of electrons by helium molecular ions, i.e., $He_2^+ + e \rightarrow He^* + He + (KE)$, is the recombination reaction taking place, an attempt was made to detect the kinetic energy of dissociation of the excited atoms produced in the recombination process by a study of the widths of the emitted afterglow lines. A model of the low-pressure helium afterglow which reasonably accounts for the electron density, line intensity, and linewidth observations involves principally the creation of $He^+$ ions and electrons by the collisions of pairs of helium metastable atoms, the three-body conversion of $He^+$ ions to $He_2^+$ ions, the ambipolar diffusion of $He^+$, $He_2^+$, and electrons, and the diffusion of helium metastable atoms to the walls. The λ5876 radiation ($3^3D-2^3P$ transition) from the later part of the afterglow, when recombination of $He_2^+$ and electrons is expected to be the source of the excited atoms, exhibits a substantial broadening over the approximately thermal width observed during the discharge and in the early afterglow, when the radiation is expected to originate from electron impact excitation of helium atoms. It is concluded that the dissociative recombination process is the likely source of the observed afterglow line broadening. (auth)

**22968** BOUND STATES IN A DEBYE-HÜCKEL POTENTIAL. Charles Ray Smith (National Bureau of Standards, Boulder, Colo.). Phys. Rev., 134: A1235-7(June 1, 1964).

The properties of the discrete energy levels of an electron in an exponentially shielded Coulomb potential, which is known in plasma physics as the Debye-Hückel potential and in nuclear physics as the Yukawa potential are investigated. A system with this potential possesses a finite number of bound states and these states are not degenerate with respect to the orbital angular momentum. First-order perturbation theory is used to obtain simple, analytical expressions for estimating the energy levels; the approximations appear to be quite accurate for large values of the Debye length. The perturbation calculations lead to an estimate of the number of bound states as a function of the Debye length. The matrix elements of the hamiltonian for this potential are calculated in the representation of the hydrogen atom wave functions. The hamiltonian matrix may serve as a convenient starting point for several other methods of computing the energy levels. (auth)

**22969** A QUASI-LINEAR THEORY OF CLASSICAL ELECTRON PLASMAS WITH FAR-DISTANCE COLLISIONS. Y. H. Iohikawa (Nihon Univ., Tokyo), M. Watabe, and K. Yamada. Progr. Theoret. Phys. (Kyoto), 31: 153-4 (Jan. 1964).

It has been argued that the Pines-Schrieffer kinetic equation for the electron-plasmon system has no equilibrium solution for an arbitrary distribution of electron momenta. It is shown, however, that this equation can describe a quasi-linear behavior of a classical plasma with collisions, when the plasma has an unstable velocity distribution. (M.J.T.)

**22970** ELECTROMAGNETIC PROPERTIES OF FINITE PLASMAS. M. P. Bachynski and K. A. Graf (RCA Victor Co., Ltd., Montreal). RCA Rev., 25: 3-53(Mar. 1964)

The determination of plasma properties by the transmission or reflection of electromagnetic waves depends upon (1) the availability of a theory that adequately describes the physical situation and (2) experimental measurements that are amenable to theoretical interpretation. The major limitations are the finite size of the plasma, the effect of the boundaries of the plasma and the material boundaries that contain the plasma, and the nonuniformity of the plasma in space and time. Expressions are derived and typical numerical values presented for the following topics: effects of plasma and dielectric boundaries on electromagnetic-wave transmission, reflection, and absorption; refractive defocusing of plane and spherical incident waves by slab- and cylindrical-geometry plasmas; effects of plasma nonuniformity both parallel and normal to the direction of propagation; and diffraction introduced by the finite size of a circular slab of plasma. (auth)

**22971** REFLECTION EXPERIMENTS WITH ELECTROMAGNETICALLY PRODUCED SHOCK WAVES OF HIGH MASS NUMBER. Wilhelm Fucks and Rolf Theenhaus (Technische Hochschule, Aachen). Z. Physik, 177: 269-73 (1964). (In German)

In a 80 cm long quartz tube of 33 mm diameter, plasma is generated by theta-pinch mechanism with conical coil and accelerated along the axis of the tube. A luminous front is observed, and its velocity has been studied as a function of coil distance and initial pressure. In He in a pressure range from 0.3 to 5 torr it has been found by reflection experiments that before the luminous front a discontinuity in the pressure is moving ahead of the luminous front. The distance Δx between the discontinuity and luminous front increases with increasing distance from the coil and with increasing initial pressure for instance up to 10 cm at a distance of about 50 cm and an initial pressure of 5 torr. The results are compared to theoretical considerations. (auth)

**22972** ACTION OF HIGH-INTENSITY LIGHT ON MATTER AND ON PARTICLE BEAMS IN A MAGNETIC TRAP. G. A. Askar'yan, N. B. Delone, and M. S. Rabinovich (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 46: 814-16(Feb. 1964). (In Russian)

Potential methods are reviewed for introducing fast ions, created either by the dispersion of dense matter exposed to a powerful light flash or by the action of high-intensity light on a fast particle beam, into a magnetic trap. Heating the ions by means of electron collisions in the focused coherent light beam is not considered effective; it appears preferable to let the light interact with the dense matter present in the trap because, in view of the dispersion of the plasma, the energy is directly transferred to the ions captured by the magnetic field of the trap. The energy of the directed motion of the ions was calculated, assuming various time-

dependent changes in the plasma pressure. In view of the small size of the portion to be heated, a strong pulsed magnetic field must be used for the confinement of the plasma. In order to effect the action of the high-intensity light on fast-particle beams, the charged particles must change their mass, velocity, or charge after entering the trap. Use of the strong electric field of the high-intensity coherent light beam is desirable for the dissociation or the ionization of molecular ions or molecules or the ionization of neutral atoms in the trap. (TTT)

**22973** WAVE INTERACTION AND DYNAMIC NONLINEAR PHENOMENA IN PLASMAS. PAPERS PRESENTED AT A CONFERENCE AT THE PENNSYLVANIA STATE UNIVERSITY, FEBRUARY 4 TO 6, 1963. University Park, Penna., Pennsylvania State Univ., 1963. 239p. $5.00.

Nine complete papers are included; separate abstracts were prepared for all. (M.J.T.)

*For abstracts of individual papers see: 22324, 22974, 22975, 22976, 22977, 22978, 22979, 22980, and 22981.*

**22974** ELECTROMAGNETIC NONLINEAR INTERACTION AND REFLECTION FROM A PLANE IONIZED MEDIUM. p.3-41 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

The reflection properties of an isotropic ionized medium were studied in the presence of nonlinear effects produced in the medium by a separate, very powerful pump wave of angular frequency $\omega_p$. It is shown, to the first order, that if a primary signal of angular frequency $\omega_0$ impinges on the disturbed medium at some specified angle, waves of frequencies $\omega_0$, $\omega_p$ and $\omega_0 - \omega_p$ are returned from the layer. Laws of reflection and refraction are deduced for these waves. Parametric resonance amplification of the sum and difference waves is discussed. Properties of these secondary waves inside the medium are investigated. The case for a slowly varying inhomogeneous medium is approximated. Applications to ionospheric radio-wave and ionized meteor-trail investigations are touched upon. (M.J.T.)

**22975** DYNAMIC NONLINEAR ELECTROMAGNETIC WAVE PROPAGATION AND HARMONIC RADIATION IN MAGNETOIONIC MEDIA. p.42-70 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

Nonlinear propagation studies are extended to a magnetoionic medium with wave normals assumed parallel. The occurrence of traveling-wave resonances is discussed. Conditions of interaction instabilities are surveyed. Parametric harmonic pumping of cyclotron-type resonances is especially probable. Harmonic or echo generation levels are described. Applications of these results to studies of topside ionospheric phenomena and exospheric whistler modes are mentioned. (M.J.T.)

**22976** WHISTLER MODE AND IONIZED STREAM INTERACTIONS. O. E. H. Rydbeck and J. Askne. p.71-111 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

An interaction by which the incoming fast cyclotron waves of an ionized stream are reflected as backward whistler modes is studied. For zero angle between the wave normal and the static magnetic field, the forward whistler mode and the cyclotron wave do not interact. For a nonzero angle, 8 waves—4 magnetoionic, 2 cyclotron, and 2 space-charge—can interact. Backward whistler generation should be very probable in the exosphere. Amplification of the forward whistler mode by the streaming medium is described. Space-charge wave properties are discussed. Wave propagation properties of a moving magnetoionic medium are covered. The case where the stream is at an angle with the magnetic field is considered. (M.J.T.)

**22977** ON THE NONLINEAR THEORY OF MULTI-STREAM ELECTRONIC DEVICES. C. L. Dolph and R. J. Lomax (Univ. of Michigan, Ann Arbor). p.125-37 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

A numerical method for high-speed digital computer, similar to the spherical-harmonic method of neutron transport theory, is presented in a form suitable for microwave and plasma applications. Expansions in terms of Hermite functions are employed, utilizing the previous systematic development of these expansions described under the name "pansions." The discussion is limited to the one-dimensional traveling-wave tube problem as determined by the Brillouin transmission-line approximation and to the Landau and Vlasov transport equation. (M.J.T.)

**22978** BEAM-PLASMA AMPLIFIER EXPERIMENTS. Paul Chorney (Microwave Associates, Inc., Burlington, Mass.). p.138-46 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

Experiments directed toward demonstrating the feasibility of using the beam-plasma interaction to amplify millimeter waves are described. Discharges with plasma frequencies near 60,000 Mc were generated by means of a dual hot-cathode Penning discharge at low pressures. The densities were measured by Langmuir probe techniques. Amplification experiments at 10,680 Mc produced net gains as high as 25 db and electronic gains as high as 60 db.(auth)

**22979** EFFECT OF NONUNIFORM PLASMA DENSITY ON ELECTRON BEAM-PLASMA INTERACTION. G. A. Swartz and L. S. Napoli (Radio Corp. of America, Princeton, N. J.). p.147-56 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

A 23 kMc microwave amplifier that utilizes the two-stream instability as a gain mechanism was constructed. The two-stream instability is generated by passing a 1400 v electron beam through a cesium plasma 3 cm long, with a density that can be varied in a range up to $10^{13}$ ions/cm$^3$. The plasma is generated by a Penning discharge. Microwave power is coupled on and off the beam with helices. The electronic gain shows a maximum at one or more measured plasma densities. The number of maxima depends on the magnetic field, percent ionization of the plasma, electron temperature of the plasma, and the input power level. The maximum electronic gain is 40 db, and the net gain for the tube is 8 db. A probe placed in the plasma 1.5 mm from the beam indicated an increase in the saturated ion current to the probe as the microwave power was increased above 1 mw. (auth)

**22980** NONPLANAR PHENOMENA IN SINGLE AND MULTIPLE ELECTRON BEAMS. Theodore G. Mihran (General Electric Research Lab., Schenectady, N. Y.). p.157-88 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

Attention is directed toward nonlinear phenomena that occur in electron beams of finite radius drifting in a region free from external fields after receiving density or velocity modulation at an input plane. The one-dimensional single-

beam bunching theory of Webster is reviewed, and its modification in the case of finite diameter beams at small signal levels as given by Hahn and Ramo is discussed. The need for a large-signal finite beam theory leads to the disk-electron model of Tien and co-workers. In calculations made by Webber this model correctly predicts the phenomenon of harmonic growth, which subsequently was verified experimentally by Mihran. Paschke and Olving recently developed a closed-form analytic theory for this effect. New computer calculations are reported that point up a basic disagreement with the Paschke-Olving theory in that signal level is found to affect profoundly the functional dependence of harmonic current with distance. Plots of phase shift versus distance for the fundamental and the first two harmonic currents of a space-charge wave are shown to give an excellent picture of the loss mechanism inherent at medium signal levels in space-charge wave propagation along finite diameter beams. The extension by Yu and Mihran of the nonlinear disk-electron analysis to the case of multiple electron streams of finite diameter is discussed. Two applications of this analysis are given: (a) calculation of the saturation characteristics of double-stream amplification, in which the harmonic levels are found to exceed the fundamental level; and (b) damping of a space-charge wave in multiple (four and eight) stream flow, which again is found to be accompanied by pronounced harmonic growth. One possible interpretation of this phenomenon is that it represents spatial Landau damping. (auth)

**22981** MULTIDIMENSIONAL NONLINEAR THEORY OF MICROWAVE INTERACTION. J. E. Rowe (Univ. of Michigan, Ann Arbor). p.189-204 of "Wave Interaction and Dynamic Nonlinear Phenomena in Plasmas." University Park, Penna., Pennsylvania State Univ., 1963.

Nonlinear interactions between accelerated streams (ions and/or electrons) and electromagnetic waves are discussed in the framework of a Lagrangian analysis. One-, two-, and three-dimensional analyses are developed, including arbitrary magnetic fields as specified by $\omega_c/\omega$. The cold plasma approximation is generally used but can easily be removed. Digital computer solutions of the nonlinear equations yield information on the growth rate and phase of the electromagnetic wave, in addition to velocity, phase, and harmonic current values for the stream charges as functions of distance and rf signal amplitude. Finally it is shown that the nonlinear equations can be solved in closed form in the framework of a hard-kernel bunch description of the stream charge. (auth)

**22982** CONTRA-ROTATING PLASMA SYSTEM. William R. Baker and K. Halbach (to U. S. Atomic Energy Commission). U. S. Patent 3,132,996. May 12, 1964.

A magnetohydrodynamic apparatus for heating plasma is described. The invention utilizes a cylindrical housing with an axial electrode, both at a negative electrical potential, and at least one intermediate positive cylindrical electrode which is spaced apart and projects into at least one end of a magnetic mirror containment region. A gas is emitted into the central region and the crossed electric and magnetic fields cause oppositely rotating cylindrically shaped plasma bodies to form, one inside the other. The device is arranged so that the oppositely directed plasma particles achieve their highest velocity at the interface between the plasma bodies, the plasma particles collide at the interface to cause nuclear reactions. (AEC)

## Shielding

**22983** (CEA-Bib-40) BÉTONS DE PROTECTION. (Protective Concretes). Frédéric Dubois (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 34p.

References (333) on the technology of concretes used in nuclear industry are given to books and U. S. and foreign journals and reports published from 1938 through Feb. 1963. A separate author index is included. (P.C.H.)

**22984** (NYO-10721) RADIOISOTOPE SHIELDING DESIGN MANUAL. William H. Steigelmann (Franklin Inst. Labs. for Research and Development, Philadelphia). July 1963. Contract AT(30-1)-3042. (F-B1978). 140p.

Includes Appendices A through B.

Forty-two radioisotope sources, 5 additional equilibrium combinations of parent-daughter isotopes, and mixed fission products with 5 decay times are considered. Graphs are given of unshielded dose rate vs distance from a point source, for gamma, x, and neutron radiations. Dose attenuation vs shielding thickness is plotted for 5 shielding materials—water, concrete, steel, lead, and uranium. Methods of calculation are described. (M.J.T.)

**22985** (TO-B-64-31) MONTE CARLO COMPUTATION OF 100,000 1-Mev GAMMA RAYS SCATTERED BY CONCRETE SLABS. Final Report. Dominic J. Raso (Technical Operations Research, Burlington). Mar. 1964. Contract NBy-32237. 71p.

Monte Carlo calculations were performed to determine the backscattering of 1.0-Mev gamma rays from concrete and their transmission through slabs of this medium. The radiation was assumed to be incident at various angles on a semi-infinite medium and on slabs with thicknesses of 0.55, 1.1, 2.2, and 4.4 mfp. Case histories of 100,000 photons were followed in groups of 20,000 on an IBM 7094 digital computer for each of six incident angles. Differential dose and number distributions as a function of azimuthal and polar angles are tabulated. (auth)

**22986** A SIMPLE QUANTUM MECHANICAL INTERPRETATION OF FAST NEUTRON SHIELDING. E. Beynan. Atomkernenergie, 9: 99-100(Mar.-Apr. 1964). (In German)

Quantum mechanical terms can play a useful role in shielding calculations. An example is given. (auth)

**22987** A MONTE CARLO METHOD FOR THE ANALYSIS OF GAMMA RADIATION TRANSPORT FROM DISTRIBUTED SOURCES IN LAMINATED SHIELDS. M. Leimdoerfer (Research Inst. of National Defence, Stockholm). 36p. (CONF-187-126)

From American Nuclear Society Meeting, New York, Nov. 1963.

A method for calculating the penetration and energy deposition of gamma radiation, based on Monte Carlo techniques, is described. The essential feature is the application of the exponential transformation to promote the transport of penetrating quanta and to balance the steep spatial variations of the source distributions which appear in secondary gamma emission problems. The estimated statistical errors in a number of sample problems, involving concrete shields with thicknesses up to 500 cm, are shown to be quite favorable, even at relatively short computing times. A practical reactor shielding problem is also shown, and the predictions are compared with measurements. (auth)

# REACTOR TECHNOLOGY

## General

**22988** (BNL-838) THE NUCLEAR REACTOR COMES OF AGE. Jack Chernick (Brookhaven National Lab., Upton, N. Y.). Nov. 13, 1963. Contract [AT(30-2)-Gen-16]. 18p. Brookhaven Lecture Series No. 31.

The design and uses of nuclear reactors are reviewed. Topics covered include: components of a nuclear reactor, the first nuclear reactor, development of reactors, the future of the reactor, and Brookhaven's reactors. (M.C.G.)

**22989** (TID-7662) REACTOR KINETICS AND CONTROL. Proceedings of a Symposium held at the University of Arizona, March 25-27, 1963. 2nd AEC Symposium Series. (Arizona. Univ., Tucson). Apr. 1964. Contracts [AT(11-1)-367, AT(11-1)-384, and W-31-109-eng-38]. 593p.

Theoretical studies and experimental results in the field of reactor kinetics and control are discussed. Separate abstracts are prepared for 25 of the 29 papers presented. Abstracts of four papers previously appeared in NSA 17: 28444, 35108, 40343, and 18: 4696. (C.E.S.)

*For abstracts of individual papers see: 23003, 23015, 23016, 23017, 23018, 23019, 23020, 23021, 23022, 23023, 23024, 23025, 23026, 23027, 23028, 23063, 23064, 23065, 23086, 23102, 23103, 23104, 23105, 23106, and 23107.*

**22990** THE DETERMINATION OF ENERGY-DISTRIBUTION OF FAST-NEUTRON-FLUXES IN REACTORS. W. Koehler (Technische Hochschule, Munich). Atomkernenergie, 9: 81-92(Mar.-Apr. 1964). (In German)

The different methods for the determination of fast neutron flux energy distribution by threshold-reaction activation or fission rate are discussed. Most of the methods, in spite of complicated computing, give only comparatively rough information. They are not suitable for general application. For measurements in thermal reactors, it seems favorable to express the energy dependence of the threshold detectors in the calculated flux distribution by the quantity $\sigma_0$ (max. value of cross section) and $E_{eff}$ (position of step-function), and to compare the measured neutron fluxes with the calculated ones. The energy distribution of the neutron fluxes is given by different authors for the usual moderator substances like $H_2O$, $D_2O$, and graphite, and should be used in the measurements. For fast reactors, the variation of the parameter in the law of fission-neutron distribution is applicable. All experiments, which do not need the explicit law of neutron flux energy distribution, should be characterized by the ratio of activities (spectral indices). These quantities are easily obtained in different irradiation facilities and give a possible comparison between them. The semiempirical interpolation between the measured fast flux and the low-energy measured epithermal flux is discussed. This interpolation gives the neutron flux per energy interval for energy regions for which no suitable methods of flux measurements are known. 87 references. (auth)

**22991** NUCLEAR REACTOR BLAZE POSES FIRE-FIGHTING PROBLEMS. Fire, 56: 157; 166(Aug. 1963).

A fire occurred inside the reactor vessel under construction at the Nuclear Power Station, Dungeness. Fire fighters were unable to use water as it would damage the expensive vessel and $CO_2$ proved ineffective in containing the fire. The smoke was so intense that breathing apparatus proved useless. The vessel was sealed off until a drop in temperature indicated the fire was extinguished by air starvation. The problems and losses involved are discussed. (C.H.)

**22992** ADVANCES IN NUCLEAR SCIENCE AND TECHNOLOGY. VOLUME 2. Ernest J. Henley and Herbert Kouts, eds. New York, Academic Press, 1964. 384p. $14.00.

Separate abstracts were prepared for five of the six sections; the remaining section was previously included in NSA (17: 22796). Analyses, critiques, and interpretations of current advances in atomic energy are given. Numerous references. (R.E.U.)

*For abstracts of individual papers see: 22161, 22862, 22993, 22994, and 23076.*

**22993** REACTOR TRANSFER FUNCTIONS. Cesar Sastre (Brookhaven National Lab., Upton, N. Y.). p.1-39 of "Advances in Nuclear Science and Technology. Vol. 2." New York, Academic Press, 1964.

The theory and application of transfer functions for reactor systems are discussed. 62 references. (R.E.U.)

**22994** SOME ASPECTS OF THE USE OF DIGITAL COMPUTERS IN NUCLEAR REACTOR DESIGN. Bernard W. Roos and Ward C. Sangren (Computer Applications, Inc., San Diego, Calif.). p.303-59 of "Advances in Nuclear Science and Technology. Vol. 2." New York, Academic Press, 1964.

The effects of digital computers on nuclear reactor calculations, and some numerical techniques used in reactor codes are discussed. Multigroup diffusion, transport, kinetics, burnup, Monte Carlo calculations, shielding, engineering, and physics codes are considered. 76 references. (R.E.U.)

**22995** MATERIALS AND FUELS FOR HIGH-TEMPERATURE NUCLEAR ENERGY APPLICATIONS. Proceedings of the National Topical Meeting of the American Nuclear Society, San Diego, April 11-13, 1962. M. T. Simnad and L. R. Zumwalt, eds. Cambridge, Mass., The M.I.T. Press, 1964. 421p. $12.00.

Recent developments in materials and fuels for power reactors, nuclear rockets and ramjets, radioisotope power systems, and thermionic converters are reviewed. Fissionable and fertile refractory oxides and carbides, graphite, zirconium hydride, beryllium, beryllium oxide, control and poison materials consisting of compounds of boron and the lanthanons, coolants for high temperature operations such as helium, molten salts, and liquid metals, and structural materials such as alloy steels, refractory metals, and pressure-vessel steels are considered. Separate abstracts were prepared for 9 of the 16 papers presented; 7 papers were previously included in NSA (16: 15948, 32148, 32128; 17: 10062, 35219; 18: 7307, 14368). (R.E.U.)

*For abstracts of individual papers see: 22518, 22519, 22715, 22996, 22997, 23040, 23041, 23042, and 23093.*

**22996** MATERIALS PROBLEMS IN MOLTEN SALT REACTORS. W. R. Grimes (Oak Ridge National Lab., Tenn.). p.96-129 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964.

Fuel mixtures suitable for MSRE are discussed, and some properties of $LiF-BeF_2-ZrF_4-UF_4$ are given. Considerations in the choice of fuel and coolant for MSRE and the production and handling of fluoride mixtures are discussed. Materials compatibility and the performance of INOR-8 are reported. 53 references. (R.E.U.)

**22997** CORROSION IN LIQUID-METAL COOLED REACTORS. John R. Weeks (Brookhaven National Lab., Upton, N. Y.). p.345-65 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964. (BNL-7005)

The general nature of corrosion by liquid metals and some specific corrosion problems encountered in liquid-metal-cooled reactors are discussed. The alkali metals and noble metals are considered. 62 references. (R.E.U.)

**22998** NON-CONVENTIONAL LUBRICANTS AND BEARING MATERIALS SUCH AS USED IN NUCLEAR ENGINEERING. PROCEEDINGS OF THE FIRST ANNUAL MEETING OF THE LUBRICATION AND WEAR GROUP, MANCHESTER, 12TH APRIL 1962. London, The Institution of Mechanical Engineers, [1962].

Eight papers are included; a separate abstract was prepared for one. Four papers on performance of graphite and graphite films as bearing surfaces for use in nuclear reactors, unlubricated metals as bearings for carbon-dioxide-cooled nuclear reactors, friction and wear behavior of possible bearing materials in high-purity liquid sodium at temperatures up to 500°C, and lubricants for nuclear reactors were previously abstracted and appear in NSA as 16:29432, 16:29079, 16:29080, and 16:2279, respectively (P.C.H.)

**22999** MATERIALS AND RATINGS FOR DRY-RUNNING GEARS. H. J. Watson (David Brown Industries Ltd., Huddersfield, Eng.). p.3-9 of "Non-Conventional Lubricants and Bearing Materials such as used in Nuclear Engineering." London, The Institution of Mechanical Engineers, [1962].

Experimental work necessary to determine a satisfactory material combination for worm gears operating without lubrication is described for discs and gears. The effect of different surface treatments applied to gear-tooth flanks was investigated and findings are discussed. A comparison made between the Novikov and involute tooth forms on double helical gears running dry showed the latter to be superior for wear resistance under the test conditions used. Practical methods of establishing permissible rating criteria are described. (P.C.H.)

**23000** METHOD AND DEVICE FOR THE EXCHANGE OF CORES IN HEAVY WATER REACTORS. Bernt Torsten Allan Hargoe and Anton Ingvar Holtz (to Aktiebolaget Atomenergi, Stockholm). German Patent 1,161,360. Jan. 16, 1964. Priority date Dec. 7, 1959, Sweden.

The method described comprises the steps: (1) of letting the heavy water out of the core, storing it in a container, and spraying the fuel elements with heavy water, (2) of blowing a gaseous medium into the reactor vessel, spraying the fuel elements with normal water, washing out the residual heavy water, and collecting the mixture of heavy and normal water in a collecting basin, (3) of filling the reactor with normal water up to a predetermined level and exchanging the core in a known manner, (4) of letting the light water out of the core, closing the reactor, and spraying the fuel elements with normal water, (5) of blowing a gaseous medium into the reactor vessel, spraying the fuel elements with heavy water, washing out the residual normal water, and collecting the mixture of heavy and normal water in a collecting basin, and (6) of filling the reactor with heavy water up to a predetermined level and starting the reactor. A device for carrying out the method described is given. (Gmelin Inst.)

## Auxiliaries and Components

*Refer also to abstracts 22334, 23107, and 23139.*

**23001** (IITRI-T6042-4) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report, October–November 1963. (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract AT(11-1)-578. 22p.

Work on the debugging of the FORTRAN computer codes for calculation of wave transmission in layered composites of crushable shield materials is continued. Shock tube tests on the six crushable materials are complete and the results show the unloading path from each Hugoniot state. For the coolant decompression experiments, a description is given of the three-dimensional receiver vessel for experiments with the high-pressure one-dimensional driver vessel. (N.W.R.)

**23002** (ORNL-3591(p.191-8)) FISSION PRODUCT RETENTION IN REACTOR CONFINEMENT SYSTEMS. (Oak Ridge National Lab., Tenn.).

A combination of filters and charcoal traps, proposed for use in the confinement system of the Oak Ridge Research Reactor, was tested in the Hot-Cell Confinement Mockup Facility and in the laboratory using irradiated uranium-aluminum alloy specimens as the source of fission product aerosols. A minimum efficiency of 99.97% for retention of radioiodine and an efficiency greater than 99.99% for retention of particulate matter were found with aerosols produced in normal air and in a steam–air mixture. A method of characterizing radioactive aerosols by use of a series of uniform fibrous filters was developed. The distribution of radioactive particles in the fibers is interpreted in terms of the three main mechanisms of filtration, which are diffusion, interception, and inertial impaction. The data obtained at flow rates of 10 to 88 fpm (interceptional and impaction regions) were analyzed in terms of theories of fiber filtration. These experiments were conducted with filter mats having a volume fraction of fibers well above the region treated theoretically. Extrapolation of theoretically predicted curves yielded fiber efficiencies not in agreement with those obtained experimentally, making it difficult to estimate particle sizes accurately in the higher flow range. Experiments in which the volume fraction of fibers was lowered to less than 0.1 were completed, and analysis of these data is in progress. It is believed that these data can be treated according to a theory of filtration to characterize particle sizes more accurately in this flow region. Certain processes which tend to limit or attenuate the escape of fission products were not fully utilized in predicting the consequences of a nuclear-reactor accident. Theoretical analyses of two such processes were performed to determine whether the attenuation effects are of sufficient magnitude to warrant further investigation or to warrant possible consideration in containment system design. A study was made of the process of diffusional deposition of particles in containment vessel leaks. Particles containing significant amounts of hazardous fission products will be produced during a nuclear reactor accident. Viscous flow equations were combined with equations for the penetration of particles through diffusion channels to give expressions relating decontamination factor with leak dimension; two leak geometries were considered: cylindrical and thin rectangular. The decon-

tamination factor was found to be a strong function of both leak dimension and particle size, increasing as either decreases. Calculated decontamination factors of 50 and higher were obtained for particles 2 $\mu$ and less in diameter if leaks corresponding to $10^{-6}$ $cm^3/sec$, as measured under accident conditions, are eliminated. A theoretical study was made of particle agglomeration and its effect on the penetration of filter systems in dual containment systems by fission products carried by particulate matter. A simplified model was analyzed in which the particulate matter was assumed to be pure iodine, and all particles with diameters less than 0.3 $\mu$ were assumed to penetrate the filters. It was shown that agglomeration would occur rapidly enough that the particles, even though initially much smaller, would reach a 0.3-$\mu$ size in a short time (<20 min for typical water reactor systems). This time is directly proportional to the containment volume and inversely proportional to the power level. Assuming that the filter efficiency of the secondary-containment sweep-gas filtration system is zero for particles less than 0.3 $\mu$ in diameter, the fraction of the core activity released to the atmosphere during that time was calculated for some conditions of interest. For one reactor system treated, less than $10^{-5}$ of the iodine available would be released. It was shown that conditions existing during a reactor accident could not be as pessimistic as those of this model. Studies of the behavior of iodine in activated charcoal systems are continuing in support of the NS "Savannah" program. Additional tests indicated that variation in composition of the iodine vapor source was the most probable cause of several cases of abnormal iodine penetration of charcoal beds observed earlier in small-scale laboratory tests. Mass spectrometric analysis indicated the presence of trace quantities of HI, ICl, $CH_3I$, and two unidentified masses, in addition to molecular iodine. Diffusion channel analysis indicated diffusion coefficients in air of 0.10 $cm^2/sec$, representative of low-molecular-weight compounds such as HI or $CH_3I$, and 0.08 $cm^2/sec$, probably representative of $I_2$. The effectiveness of activated charcoal for removing the volatile compounds of iodine was studied. Moisture in a room-temperature system lowers the effectiveness of charcoal for iodine compounds, but this effect diminishes at temperatures around 100°C. Whetlerite charcoal produces efficiencies of >99.9% for removal of iodine compounds in the presence of moisture at 100°C. In-place testing of the activated charcoal units in the reactor compartment ventilation system of the ship is continuing. A total of 16 normal iodine tests ($^{127}I$) and 8 radioactive tests ($^{131}I$) on the charcoal units installed in March–April 1963 indicated that satisfactory performance of these units can be expected. (auth)

**23003** (TID-7662(p.491-500)) SOME REQUIREMENTS FOR PRESSURE INSTRUMENTATION IN EVALUATION OF REACTOR INCIDENTS. E. Feinauer and G. F. Brockett (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

The salient characteristics that define a pressure pulse of the type that might accompany a reactor incident are considered, and a few of the requirements imposed on suitable detecting and recording instrumentation by these characteristics are discussed. (C.E.S.)

**23004** REACTOR VIEWING EQUIPMENT. BARR AND STROUD SYSTEM FOR DRAGON. Nucl. Eng., 9: 176-7 (May 1964).

A combined periscope-television system included in the primary containment of the HTGR project Dragon is described. (R.E.U.)

**23005** THE PERIOD METER UTILIZING MAGNETIC CORE FOR NUCLEAR REACTOR INSTRUMENTATION. Yoshifumi Sakurai and Seiji Inokuchi (Osaka Univ.). Technol. Rept. Osaka Univ., 13: 297-302(Oct. 1963).

A problem of nuclear reactor period computation is considered. The design of a period circuit utilizing the flux memory of a magnetic core element is described. The digital signal that comes from this circuit is convenient for use with reactor control equipment. In this experiment, a Deltamax core is used as the flux memory. The output is a 1-kc clock pulse, which comes through the gating circuit only during the interval relating to the reactor period. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**23006** HYDRAULIC DRIVE MEANS FOR CONTROL MEMBERS IN NUCLEAR REACTORS. Hermann Kumpf (to Siemens-Schuckertwerke AG). German Patent 1,160,559. Jan. 2, 1964. Filed July 16, 1959.

The hydraulic drive means described is for driving a control member, which may, for example, be a control rod that is guided in a tubular insert extending into the reactor core wherein the control member is coupled to a piston that is longitudinally movable in the pertaining tubular insert and has a hydraulic pressure medium acting thereon. The coolant of the reactor is at the same time utilized as hydraulic driving medium, whereby appropriate parts of the existing coolant circuit may be employed as sources of higher or lower pressure to drive the piston. An essential feature of the invention is that the motion of the piston is controlled by an electromagnet that is moved longitudinally outside the tubular insert and acts upon a throttle valve inside the tubular insert. (Gmelin Inst.)

**23007** ARTICLE HANDLING DEVICE. Kenneth A. Trickett (to U. S. Atomic Energy Commission). U. S. Patent 3,130,841. Apr. 28, 1964.

An article handling device capable of operating within a reactor pressure vessel through a maintenance port is described. A conventional grappling mechanism is carried by an arcuate arm which is guided by cam tracks and rollers. The cam and rollers are enclosed in a housing that can be movably positioned within a maintenance port. (AEC)

**23008** NEUTRONIC REACTOR FUEL ELEMENT. E. Frisch (to U. S. Atomic Energy Commission). U. S. Patent 3,133,867. May 19, 1964.

A fuel element assembly and support means therefor wherein a plurality of fuel rods in a lattice network are supported by a series of straps, each secured to a row of fuel rods in one direction, and a series of dividers between adjacent rows of the lattice positioned at an angle to the straps and each secured to all of the straps are described. (C.E.S.)

## Criticality Studies

**23009** (ANL-6809) INTRODUCTORY FAST REACTOR PHYSICS ANALYSIS. David Meneghetti (Argonne National Lab., Ill.). Dec. 1963. Contract W-31-109-eng-38. 96p.

An introduction to calculational analyses of fast reactor physics for persons reasonably familiar with thermal reactor physics is presented. Fast reactor characteristics, breeding, multigroup methods, cross-section definitions and evaluations, discrete ordinate transport methods, transport approximation, $B_N$ method, asymptotic diffusion theory, equilibrium spectra, resonance effects, perturbation analysis, shape factor, lifetime, delayed-neutron fraction, reactivity-period relations, coupled systems, sodium

void effect, and Doppler effect are discussed. 81 references. (auth)

**23010** (ANL-6850) CALCULATIONS OF k FOR SOME SMALL $U^{233}$-, $U^{235}$-, AND $Pu^{239}$-FUELED FAST REACTORS. W. G. Davey (Argonne National Lab., Idaho Falls, Idaho). Feb. 1964. Contract W-31-109-eng-38. 12p.

Values of the multiplication constant were calculated for a number of small $^{233}U$-, $^{235}U$, and $^{239}Pu$-fueled fast reactors using a cross-section set previously used to study a number of $^{235}U$-fueled ZPR-III assemblies. The reactors considered are GODIVA, TOPSY, JEMIMA, JEZEBEL, POPSY, and $^{235}U$ assemblies constructed at Los Alamos; three Pu-graphite critical assemblies constructed with the reactor VERA at AWRE; the Pu-fueled Mark-IV loading of the EBR-I reactor; and Pu- and $^{235}U$-fueled mockup in ZPR-III of a proposed French reactor, RAPSODIE. (auth)

**23011** (GAMD-2871) THE HOMOGENIZATION OF HETEROGENEOUS SLAB LATTICES CONTAINING BeO AND HYDROGEN. W. B. Wright (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Jan. 19, 1962. Contract AT(04-3)-187. 22p.

Four cores with different arrangements of the unit cell structure were constructed containing hydrogen (polyethylene) in a BeO lattice. The cores were made critical by adjusting the amount of distributed poison in the core, and detailed Mn activations were made within a unit cell near the core center to study the heterogeneities. The Mn activity was then calculated in multigroup transport theory. The calculations are described and compared with the experimental results. (D.C.W.)

**23012** (HW-80020(p.8-13)) THE MODIFIED HEAVY GAS EQUATION AND LIGHT-WATER-MODERATED SYSTEMS. K. B. Stewart (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The validity of the modified heavy gas equation for infinite, homogeneous, light-water-moderated systems ($Pu-H_2O$, $U-H_2O$) was investigated by comparing the neutron flux distribution obtained from the modified equation with that obtained from infinite medium balance equation. Comparisons with the unmodified heavy gas equation were also made. (D.C.W.)

**23013** (NAA-SR-7020) REACTOR KINETICS MEASUREMENTS IN HOMOGENEOUS, STATIONARY, LINEAR EXTENDED SYSTEMS. M. N. Moore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 15, 1964. Contract AT(11-1)-Gen-8. 24p.

A partial differential equation of sufficient generality to include most linear, space dependent, reactor kinetic models is considered from the point of view of its modal solution. The vibrations of this system, resulting from an arbitrary source located at a boundary, are studied. It is shown that the dispersion law of the system can readily be measured, the information being obtained from a minimal number of measurements in space but from accurate and detailed measurements in time. A method for measuring this dispersion law, without accurate knowledge of the boundary and initial conditions in the experiment, is presented. From the dispersion law measurements, the physical parameters of the system may then be obtained. (auth)

**23014** (ORNL-TM-838) KAY-CHAIN: A PROGRAM FOR CALCULATING THE MULTIPLICATION FACTOR OF HETEROGENEOUS REACTORS. E. A. Nephew and C. A. Preskitt (Oak Ridge National Lab., Tenn.). Feb. 4, 1964. Contract W-7405-eng-26. 40p.

The KAY-CHAIN program for the IBM-7090 is designed primarily to compute the infinite multiplication factor for the EGCR lattice, but may be applied to any similar cell. A flux spectrum is computed for an equivalent homogeneous cell with the integral Boltzmann equation using scattering kernels stored on a library tape. The flux spectrum up to some specified cut-off energy is defined to be the thermal flux and is used to evaluate the appropriate thermal reaction rates and the multiplication factor. The calculations of flux spectrum, cross section averages, and multiplication factor are chain linked, so that KAY-CHAIN operates as a single program. The machine time required for a typical problem consisting of a 96-point energy mesh is 1.4 min. Sample input and output are included. (auth)

**23015** (TID-7662(p.1-26)) MEASUREMENT OF REACTOR-SHUTDOWN MARGIN BY NOISE ANALYSIS. Robert E. Uhrig (Florida. Univ., Gainesville).

The measurement of reactor-shutdown margin by both power-spectral-density and cross-correlation techniques is discussed. The advantage of using the autocorrelation measurement, or power-spectral-density measurement, is that the system is not disturbed but relies upon the variation of the intensity of the neutron source normally present in most reactors as a driving function. (C.E.S.)

**23016** (TID-7662(p.46-52)) A SYSTEM FOR REACTOR-NOISE MEASUREMENT. Robert W. Albrecht (Washington. Univ., Seattle).

A system for reactor-noise measurement is described, and its merits and limitations are discussed. The fluctuations indicated by an ionization chamber near the reactor are tape recorded and prepared for the system which consists of analyzer, analyzer control and splice suppression, oscillator, power integrator, and x-y plotter. (C.E.S.)

**23017** (TID-7662(p.53-90)) PERIOD EFFECT IN REACTOR DYNAMICS. J. C. Carter, D. W. Sparks, and J. H. Tessier (Argonne National Lab., Ill.).

The term period effect is used to describe a phenomenon of considerable importance to the design of reactor-control systems. It results in the fact that a reactor control system that is stable with the reactor at steady power may be unstable when the reactor is on a period shorter than about 30 sec. The effect is due to changes in the reactor transfer function that occur when the reactor is in a dynamic condition. This effect was described independently by five authors, all using the same approach. An alternate approach is presented. The present approach demonstrates that useful insights are gained by considering the basic cause of the effect to be reactivity rather than period as the previous authors assumed. Methods for compensating for the effect are discussed. It is felt that in many systems the effect may be adequately corrected for by automatic adjustment of control loop gain proportional to the quantity $[\beta - k_{ex}(1 - \beta)]$. The well-known zero-power transfer function is shown to be a special case of the general reactor transfer function that applies under any static, quasi-static, or dynamic condition whether subcritical, supercritical, or superprompt critical. (auth)

**23018** (TID-7662(p.136-49)) PROBABILISTIC ANALYSIS OF REACTOR KINETICS. Philip R. Pluta (Michigan. Univ., Ann Arbor).

The standard reactor-kinetics equations describe the average time-dependent behavior of a reactor caused by a time-dependent reactivity. A probabilistic analysis of reactor kinetics describes the statistical nature of the fluctuations about this average behavior. The fluctuations can be characterized by their variance, autocorrelation function, and power-spectral-density function. The basis of the description of the fluctuations used is a detailed

probability balance on the various transition states of the system. When the probability balance is converted to a partial differential equation for the system probability generating function, both the average behavior and the statistical character of the fluctuations are readily determined. To illustrate this technique, a model of a point zero-power reactor with a $BF_3$ detector is considered in detail. General results for the time-dependent case are obtained. For the special case of constant reactivity, an expression for the ratio of the variance to the mean number of detected neutrons as a function of detection time is derived. General expressions for the autocorrelation function and power-spectral-density function are obtained, also. From the analysis the following may be inferred. The interrelationships between the system parameters are not simple. Fission chains do not have to be analyzed for "correlated" vs. uncorrelated neutrons, as is commonly done. An equation for the ratio of the variance to mean number of detected neutrons as a function of detection time is presented, which is more general than any result in the literature. A comparison of the general power-spectral-density function obtained from the probability balance and the spectra obtained by assuming a form for the reactor transfer function serves as a proof that a zero-power reactor has a white-noise driving function. Any system for which all the state-transition probabilities are known can be analyzed routinely in the domain of its variance, autocorrelation function, or power-spectral-density function. The probabilistic analysis is extended to describe a simple model of a boiling-water reactor, including Doppler and void coefficients of reactivity. Using the Routh–Hurwitz criterion, it is shown that the reactor is nuclearly stable for negative reactivity coefficients in the presence of stable hydraulics. (auth)

**23019** (TID-7662(p.169-78)) ROLE OF THE DISPERSION LAW IN SPACE-DEPENDENT KINETICS. M. N. Moore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

It is shown that for a reactor whose neutron density is space and time dependent there is a quantity analogous to the transfer function that is independent of the subsidiary boundary and initial conditions of the field. The quantity exists in the form of a function obtainable from the original field equation, and the roots of this function determine the field stability. (C.E.S.)

**23020** (TID-7662(p.179-88)) MEAN-SQUARE ERROR MINIMIZATION OF REACTOR NOISE. L. E. Weaver and H. S. Murray (Arizona. Univ., Tucson).

Techniques used to determine an optimum external control system to minimize random fluctuations in reactor power are described. The optimization criterion used is the mean-square error minimization of the random variations in reactor flux about a steady-state level. Reduction in the mean-square value of these random fluctuations will increase system stability and thus allow higher power densities before instability occurs. (C.E.S.)

**23021** (TID-7662(p.189-226)) FLOW-VOID FEEDBACK EFFECTS ON POWER-VOID TRANSFER FUNCTIONS AND HYDRODYNAMIC OSCILLATIONS IN BOILING-WATER REACTORS. S. M. Zivi and R. W. Wright (Space Technology Labs., Inc., Redondo Beach, Calif.).

Divergent power oscillations due to regenerative reactivity feedback between steam voids and the reactor power and large limit-cycle flow oscillations that drive reactor power oscillations by means of the effect of the void coefficient of reactivity in natural-circulation boiling water reactors are considered. Thermal conditions that permit hydrodynamic oscillations to persist are investigated. It is shown that boiling water reactor instabilities of both the power-void feedback and the purely hydrodynamic types are closely related. (C.E.S.)

**23022** (TID-7662(p.227-37)) LAGRANGE STABILITY BY LIAPUNOV'S DIRECT METHOD. Elias P. Gyftopoulos (Massachusetts Inst. of Tech., Cambridge and Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

A brief description of Liapunov's direct method and its extension to Lagrange-stable systems is given, and the method is successfully applied to examples taken from the fields of nuclear reactors and nonlinear control systems. The step response of a two-region reactor with two temperature coefficients of reactivity is considered. It is shown that when Lagrange stability is acceptable, the design specifications are more relaxed than they would be if asymptotic stability were required. (C.E.S.)

**23023** (TID-7662(p.238-52)) NONLINEAR CONTROL THEORY OF MULTIREGION NUCLEAR REACTORS. T. J. Higgins (Wisconsin. Univ., Madison) and R. F. Hill (Rhode Island. Univ., Providence).

The Fourier-series representation of the steady-state neutron-density response to a general periodic input of reactivity for a single-region reactor is detailed. Explicit solution in a particular case requires the iterative approximate solution of an infinite number of equations in an infinite number of unknowns. Less exhaustively, and for sinusoidal input, an approximation for the steady-state neutron-density by Ritz's method, requiring solution of only a finite number of equations, is detailed. Illustration of application of this theory is detailed for a reactor of specified characteristics; and a comparison of the two solutions so obtained, together with one obtained on an analog simulator, illuminates the relative degree of accuracy afforded by the two modes of analysis. Both methods of nonlinear analysis are used to obtain sets of equations characterizing the operating performance of a general, coupled, multiregion reactor, and this theory is exemplified by determination, by Ritz's procedure, of the describing function of a specified coupled two-region reactor. (auth)

**23024** (TID-7662(p.253-64)) SPACE- AND ENERGY-DEPENDENT CORRECTIONS TO THE FUCHS-NORDHEIM MODEL. R. Scalettar (General Atomic Div. General Dynamics Corp., San Diego, Calif.).

A method for obtaining space- and energy-dependent corrections to reactor kinetics in the Fuchs-Nordheim model for the case of a bare reactor in one-group theory is described. (C.E.S.)

**23025** (TID-7662(p.265-77)) APPLICATION OF PONTRYAGIN'S MAXIMUM PRINCIPLE TO FLUX-STATE CHANGES IN NUCLEAR REACTORS. Z. R. Rosztoczy, A. P. Sage, and L. E. Weaver (Arizona. Univ., Tucson).

The essential theorems of Pontryagin's maximum principle are summarized. It is shown how this method can be used in reactor control to determine the optimal control function. A one delayed-neutron-group reactor model with temperature feedback proportional to flux is considered. (C.E.S.)

**23026** (TID-7662(p.334-47)) BASIC KINETICS DATA AND NEUTRON-EFFECTIVENESS CALCULATIONS. G. R. Keepin (Los Alamos Scientific Lab., N. Mex.).

Effective prompt- and delayed-neutron yields and effective delay fractions were calculated in detail for rep-

resentative bare and reflected metal critical assemblies. (C.E.S.)

**23027** (TID-7662(p.447-90)) A DYNAMIC REACTIVITY EFFECT IN COMPRESSIBLE FISSILE MEDIA. R. E. Bailey and P. N. Powers (Purdue Univ., Lafayette, Ind.).

The effects upon the free-neutron population of periodically changing the size of an enclosure were investigated. Compressible media from scattering to fissile were considered. Analytic solutions were obtained for the case of a one-dimensional semi-infinite system with nonreflective boundaries, and a solution of the reflected counterpart was expressed in terms of a multiple integral. The net outcome was that diffusion theory predicts the occurrence of a dynamic effect in a system of free neutrons if the size of the nonreflecting enclosure is periodically changed at a rate greater than the rate with which the system can adjust itself to that change. In other words, if the geometry of the system is changing so that the driving force behind the net neutron motion cannot keep up with the change in geometry, then a different effect follows than the one that would be postulated if a stepwise series of fixed geometry problems, wherein the size of the enclosure is varied throughout the periodic displacement, were investigated. From the one-dimensional solution of the diffusion equation, it was observed that a subcritical, compressible fissile system could be made supercritical by appropriately oscillating the enclosure walls through a particular displacement at a particular frequency. (auth)

**23028** (TID-7662(p.548-81)) REACTOR STABILITY AGAINST XENON OSCILLATIONS. Louis M. Shotkin (Brookhaven National Lab., Upton, N. Y.).

The stability of the thermal flux in a reflected slab reactor due to xenon and temperature reactivity feedback is investigated with perturbation theory. A reactor with spatially constant fuel, equilibrium flux, and materials in the core is examined under various reactivity feedback situations. Stability criteria are given along with associated oscillation periods for the condition of neutrally stable equilibrium, i.e., continuous oscillation of the perturbed flux. The conditions for interaction of the xenon and temperature reactivity feedback are shown for both long and short temperature delays, the effect of delayed neutrons being considered when appropriate. A cosine fuel distribution is found to be necessary to give spatially constant equilibrium flux, and this cosine fuel model is shown to predict slightly more stable conditions than the flat fuel model. Coupling of the first two (even or odd) excited modes is shown to occur (for a constant power density model) in large high-flux reactors. Coupling leads to more unstable conditions than no coupling. (auth)

**23029** A SYSTEM OF EIGENFUNCTIONS FOR CALCULATING A CYLINDRICAL REACTOR WITH AN ARBITRARY ROD CONFIGURATION. H. Kiesewetter (VEB Atomkraftwerk, Berlin). Kernenergie, 7: 139-47(Mar. 1964). (In German)

Conventional methods for the analytical characterization of neutron flux distribution in reactors with non-constant material properties were modified to obtain a system of two-dimensional, quasi-orthogonal eigenfunctions. This system enables the characterization of the flux distortions at any given rod heterogeneity within the reactor. The system described is a natural extension of the eigenfunction system for a homogeneous, non-reflecting reactor and enables numerous pertinent numerical calculations pertaining to reactors with absorber rods and other rod-shaped heterogeneities. (P.C.H.)

**23030** WILKINS' SCATTERING MODEL AS APPLIED TO NEUTRON SPECTRUM STUDIES IN HETEROGENEOUS LIGHT-WATER MODERATED REACTORS. K. Meyer (VEB Atomkraftwerk, Berlin). Kernenergie, 7: 147-55(Mar. 1964). (In German)

Wilkins' scattering model was employed in conjunction with an integral version of the transport equation for the calculation of the neutron spectrum in heterogeneous water-moderated reactors. Both differential and integral measurements were used for obtaining the data required. The microscopical moderating cross section of water was calculated as 41.2 barn. The calculations made with the aid of the method described gave results that correlated well with experimental findings. The effects of collision probabilities are also discussed and numerical examples are presented. (P.C.H.)

**23031** THE CORRELATION FUNCTION AND POWER SPECTRAL DENSITY OF NUCLEAR REACTORS. Abdi Dalfes (Technical Univ., Istanbul). Nukleonik, 6: 53-8 (Mar. 1964).

Analytical solutions that give the covariance, the correlation, and the power spectral density matrices of a subcritical, zero-power, point reactor were derived starting from the Fokker-Planck equation. The assumptions leading to the use of the subcritical transfer function in reactor noise studies are emphasized. (auth)

## Design and Feasibility

**23032** (HW-78953) ECONOMIC EVALUATION OF A 300-$Mw_e$ FAST SUPERCRITICAL PRESSURE POWER REACTOR. D. T. Aase, J. C. Fox, R. J. Hennig, R. E. Peterson, S. L. Stewart, and K. G. Toyoda (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 9, 1963. Contract AT(45-1)-1350. 147p.

The Fast Supercritical Pressure Power Reactor (concept) is a Pu-fueled fast breeder reactor using supercritical water coolant in a direct cycle system with turbine inlet conditions of 3500 psi and 1050°F. The reactor is designed to produce 300 Mw net power and to operate with an 80% plant operating factor at a 44% net thermal-to-electrical conversion efficiency. The power generation cost was estimated to be 5.12 mill/kwh. Lower values (4.3 and 3.0) were estimated for 500 and 1000 Mw units. Improvement of the plant operating factor to 90% would lower the cost to 4.58 mill/kwh. The conceptual reactor, plant, and site are described; and reactor safety, operation, and the technological developments required are discussed. (D.C.W.)

**23033** NUCLEAR REACTOR. John M. West and R. W. Deutsch (to U. S. Atomic Energy Commission). U. S. Patent 3,132,076. May 5, 1964.

A water cooled and moderated nuclear reactor core structure is considered. Fuel assemblies, which are spaced apart within the core structure for the reception of control rods there-between, are provided with interiorally located water filled channels. The water filled channels within the fuel assemblies provide a more uniform power distribution thereacross. (AEC)

## Fuels

**23034** (HW-80020(p.4-7)) TIME-VARIANT ISOTOPIC TRANSMUTATION GE-HL PROGRAM ALCHEMY. B. H. Duane (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The bases of the program ALCHEMY that evaluates

isotope concentrations for nuclear fuel cycle analyses are presented. The isotope balance equation is expressed in terms of an asymmetric transmutation-rate matrix. Machine time varies as the cube of the number of isotopes, averages about 4 sec/pass for the 15-isotope representation used, and is independent of exposure time. (D.C.W.)

**23035** (NYO-2945-1) AN EXPERIMENT FOR NONDESTRUCTIVE ANALYSIS OF BURNUP IN IRRADIATED FUEL ELEMENTS. Final Report, February 1962–April 1964. R. H. Johnston, E. A. Vrablik, and N. C. Rasmussen (Little (Arthur D.) Inc., Cambridge, Mass.). Apr. 17, 1964. Contract AT(30-1)-2945.

A description is given of an attempt to evaluate fuel burn-up by nondestructive testing involving the use of a high-resolution curved quartz crystal gamma ray spectrometer. Initially it was hoped that the intensity of the 667 kev gamma ray emission from $^{137}Cs$ in the fission products would provide a valid measurement of burn-up. While this line could be measured in the presence of the background due to mixed fission products on a thick emulsion plate, it proved impossible to resolve this line using a scintillation detector behind a collimating slit. The reason for this inability to detect this line by scintillation technique was the degradation of signal to noise ratio resulting from the finite acceptance angle of the collimating slit. The uranium fluorescence lines were, however, clearly resolvable by scintillation techniques since in this case the energy bandwidth of the detector imposed by the finite acceptance angle of the slit is a sufficiently small fraction of the mean energy of photons admitted by the slit. This suggested that burn-up might be assessed by measuring the relative intensities of the Kα fluorescence lines in uranium and plutonium. An instrument was designed for this purpose and was shown to have the necessary resolution for measuring the uranium to plutonium ratio in laboratory tests. The instrument failed to resolve the fluorescence lines when used under water in examining spent fuel assemblies of Core I at Yankee Atomic Electric Company. This failure is attributed to a defect in shielding design. (auth)

**23036** NUCLEAR FUEL TESTING AND ITS PROBLEMS. Toshimasa Aoki (Atomic Fuel Corp., Tokyo). Hi-hakai Kensa, 12: 287-94(Dec. 1963). (In Japanese)

The selection and application of nuclear fuel tests are outlined with major points dealt with as follows: 1) specific problems in fuel inspection and testing; 2) inspection of the fuel manufacturing process—JRR-3 type fuel, GEC type fuel, PWR or BWR type fuel, MTR type fuel; 3) nondestructive testing techniques for the fuel—application of radiography, ultrasonics, eddy current, and leak testing. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**23037** STUDIES ON BURNABLE ABSORBERS. P. Wenzel (VEB Atomkraftwerk, Berlin). Kernenergie, 7: 159-62(Mar. 1964). (In German)

The effects of a homogeneously distributed absorber in enriched nuclear fuel on changes in the reactivity during burnup, and the attainable mean final slag concentration during a one-time uniform buildup in the fission zone, were approximately calculated with the aid of the single-group disturbance theory. In the calculations, the nonuniformity of flux distribution and thus of the burnup were taken into account. The findings indicate that it may be desirable to add the maximum practicable amount of burnable absorber to the fuel. (P.C.H.)

**23038** PLUTONIUM FUEL ELEMENT PRODUCTION. SURVEY OF PLANT DEVELOPMENT AT AWRE ALDERMASTON. P. A. F. White (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Eng., 9: 166-70 (May 1964).

The plutonium fuel element production processes at AWRE are described and compared with other plants. Containment, criticality, and shielding are discussed. Wet- and dry-chemical processes and fuel element fabrication are discussed. (R.E.U.)

**23039** UTILIZATION OF PLUTONIUM IN FAST AND THERMAL REACTORS. Eugene A. Eschbach (General Electric Co., Richland, Wash.). Nukleonik, 6: 94-102 (Mar. 1964). (HW-SA-3171)

The applications of plutonium fuel in thermal reactors are discussed. The role of $^{240}Pu$ as a fertile fuel including the possibility of maximizing its fertility in preference to the fertility of $^{238}U$ is included. The results and status of some of the experimental programs are noted. The logical interplay of plutonium fuel between thermal and fast reactors is reviewed, especially, in view of activities in support of large core fast reactor projects. It is observed that fast and thermal reactors will likely lend support to each other through exchange of fuel. Sixty references are included. (auth)

**23040** HIGH-TEMPERATURE GAS-COOLED REACTOR FUEL MATERIALS DEVELOPMENT. Walter V. Goeddel (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.130-69 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964. (GA-4562)

A review of research through the spring of 1962 on pyrolytic-carbon-coated fuel particles and graphite-matrix fuel compacts is presented. Fuel for the Peach Bottom High-Temperature Gas-Cooled Reactor (HTGR) will consist of pyrolytic-carbon-coated $(Th,U)C_2$ particles dispersed in graphite-matrix fuel compacts. The fuel particles are prepared from granules composed of the powdered oxides and carbon. These granules are suspended in a bed of graphite flour and heated to convert the oxides to dicarbides. The dicarbide particles are then melted to spheroidize them, while the graphite flour keeps them separated so they will not flow together. Coating the $(Th,U)C_2$ particles with pyrolytic carbon is accomplished in a fluidized-bed apparatus using a methane-helium mixture at a temperature of ~1400°C. A hot-pressing process is used to prepare high-density graphite-matrix fuel compacts containing the coated particles. Graphite flour is used as the filler and pitch as the binder; the use of graphite flour, rather than coke, permits the attainment of good thermal properties in the compacts without the necessity for high processing temperatures. Results of extensive thermal and irradiation tests have shown that these hot-pressed graphite-matrix fuel compacts containing pyrolytic-carbon-coated $(Th,U)C_2$ fuel particles will perform satisfactorily under the conditions to be encountered in the Peach Bottom HTGR. (auth)

**23041** FISSION-PRODUCT RETENTION CHARACTERISTICS OF CERTAIN $(Th,U)C_2$-GRAPHITE FUELS. L. R. Zumwalt, E. E. Anderson, and P. E. Gethard (General Atomic Div., General Dynamics Corp., San Diego, Calif.). p.170-213 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964. (GA-4551)

The results reported on the fission-product-retention characteristics of dispersion-type $(Th,U)C_2$-graphite fuels are based on relatively early developments of this type of fuel. The results demonstrate that uncoated fuel retains a

large fraction of shorter-lived (half-life ≤ a few hours) noble-gas fission products even at 1700°C. Retention at lower temperature is greater, since fission-product release from uncoated fuels is shown to be governed by diffusion from the $(Th,U)C_2$ particles, in which most of these products are deposited by recoil. Such diffusion has substantial activation energies (order of 60 to 80 kcal/mole for krypton and xenon). Pyrolytic-carbon coatings were demonstrated to increase fission-product retention and to show substantially complete retention for krypton and xenon fission products. Electropositive elements such as barium, strontium, and cesium were shown to penetrate, in varying degrees, pyrolytic-carbon coatings that are impervious to krypton and xenon. Nevertheless, the pyrolytic-carbon coating acts as a diffusion barrier to the electropositive fission products and appears to be especially effective at lower fuel temperatures (1000 to 1200°C). In-pile experiments indicate that radiation can damage pyrolytic-carbon coatings. However, these early results show that many particles did not deteriorate. It seems quite likely that current developments and tests will lead to and demonstrate that fuel-particle coatings can be made which are essentially unaffected by radiation at HTGR fuel temperatures (1000 to 1500°C). (auth)

**23042** FUELED BERYLLIUM OXIDE. A. T. Chapman and R. L. Hamner (Oak Ridge National Lab., Tenn.). p.225-41 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964.

Work on irradiation testing of fueled BeO in the United States, at British, and at Australian laboratories is reviewed with emphasis on work at ORNL. The results permit an evaluation of the potential of BeO-base reactor fuel. (R.E.U.)

**23043** IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. George Michael Emsley and John Wilfred Hughes (to Nuclear Power Plant Co. Ltd. and AEI-John Thompson Nuclear Energy Co. Ltd.). British Patent 955,755. Apr. 22, 1964. Filed Feb. 26, 1962.

A reactor fuel element is described that is in the form of a cylinder with spiral fins. Longitudinal fins that protrude beyond the spiral fins act as baffles for the flow of coolant between the spiral fins. Circumferential braces are provided on the longitudinal fins in order to provide mechanical strength. (T.F.H.)

**23044** METHOD FOR THE PRODUCTION OF NUCLEAR FUEL ELEMENTS. Wilhelm Krummreich (to Deutsche Gold- und Silberscheideanstalt). German Patent 1,158,641. Dec. 5, 1963. Filed Feb. 24, 1960.

The fuel element described consists of a preformed body of moderator material that is substantially made of graphite and of fissionable and/or breeder material located in the central portion of the moderator body. The method comprises the steps of mixing the graphite powder with soot and a liquid binding agent, of inserting the fissionable and/or breeder material into the central portion of the moderator material, and of shaping and solidifying the moderator by pressing and heat treatment. (Gmelin Inst.)

**23045** DEVICE FOR THE ASSESSMENT OF FUEL ELEMENTS FOR NUCLEAR REACTORS. R. Flinders Jackson and G. Thomas Shears (to United Kingdom Atomic Energy Authority). German Patent 1,160,560. Jan. 2, 1964. Priority date Oct. 24, 1958.

A fuel element is described that comprises a nuclear fuel member enclosed in a protective sheath having end caps welded to the sheath. Within the sheath and interposed between one end of the member and the corresponding cap is a magnesium heat-insulating disk having a cavity that contains a capsule. The capsule may be used to determine whether the fuel element has exceeded a certain temperature by selecting material for the capsule that melts at that temperature. (Gmelin Inst.)

**23046** ARRANGEMENT FOR THE LONGTIME STORAGE OF DAMAGED ACTIVE FUEL ELEMENTS OF A NUCLEAR REACTOR. Stig Ericsson, Bengt Nilsson, and Sven-Otto Brunzell (to Allmanna Svenska Elektriska Aktiebolegat). German Patent 1,160,958. Jan. 9, 1964. Priority date Dec. 31, 1959, Sweden.

A fuel storage well is described that comprises a covered water-filled pit, a storage tank situated in the lower part of the pit and containing a storage rack, a lock device for transferring the damaged fuel elements from the charging machine into the rack, and three pipe unions at three different levels for the variation of the water level in the tank. An essential feature of the invention is that any leakage of water vapor into the charging machine is avoided so that contamination of the reactor by water vapor is impossible. (Gmelin Inst.)

**23047** FUEL ELEMENTS FOR NUCLEAR REACTORS. Stanley Hackney and Ernest Edward Jerkins (to United Kingdom Atomic Energy Authority). U. S. Patent 3,128,235. Apr. 7, 1964. Priority date Jan. 24, 1958, Great Britain.

A fuel element suitable for use in a gas-cooled nuclear reactor operating at temperatures of the order of 500–600°C comprises clusters of uranium dioxide rods sheathed in Be cans and stacked on Be support plates in a graphite sleeve. Spacers for the support plates are so arranged as to allow for expansion of fuel rods and cans and to allow coolant flow through the plates. (A.G.W.)

**23048** FUEL ELEMENTS FOR NUCLEAR REACTORS. Jacques-Andre Stohr and Maurice Gauthron (to Commissariat à l'Energie Atomique). U. S. Patent 3,129,140. Apr. 14, 1964. Priority date Aug. 21, 1958, France.

The proposed reactor fuel element consists of two concentric annular sheaths between which are located annular bodies of ceramic fuel, concentric with and in contact with the sheaths. The annular bodies are spaced from one another axially and held in place by deformation of at least one sheath. Each fuel body may be a single unit or may be split into arcuate tiles. The fuel bodies may be equally spaced or spaced in groups; they may be of equal or unequal height and radial thickness. (A.G.W.)

**23049** NUCLEAR REACTOR FUEL ELEMENT AND PROCESS FOR MAKING SAME. John B. Burnham, Jr. and James G. Darrah (to General Motors Corp.). U. S. Patent 3,129,141. Apr. 14, 1964. Filed Nov. 3, 1958.

The proposed fuel element consists essentially of from 1% to 50% by weight uranium as uranium carbide and the remainder graphite, silicon carbide, and silicon. The uranium carbide is in the form of particles and agglomerates of particles at least partially covered with graphite and relatively uniformly dispersed in a matrix of silicon and silicon carbide. Graphite-bonded uranium carbide is pulverized and mixed, either alone or combined with silicon carbide grain, with a suitable resin binder. The mixture is cold or hot pressed to the desired shape and heated in a suitable atmosphere to cure the resin and drive off the volatiles. When the pressed and cured briquette is immersed for a short time into molten silicon, the resin carbonizes and reacts with the molten silicon to form silicon carbide. (A.G.W.)

**23050** FUEL ELEMENT. Warren P. Chernock (to Combustion Engineering, Inc.). U. S. Patent 3,129,142. Apr. 14, 1964. Filed Mar. 31, 1959.

The proposed reactor fuel element consists of a protective casing enclosing a homogeneous face-centered-cubic solid solution of from 5 mole % to 55 mole % $UO_2$ in stabilized $ZrO_2$. The $ZrO_2$ may be stabilized in the face-centered-cubic form by small additions of an oxide of Ca, Mg, or Y. $CeO_2$ is also suitable for use in this fuel element. (A.G.W.)

**23051** HOMOGENEOUS REACTOR FUELED WITH SUSPENDED PARTICULATE IN THE COOLANT. Harold M. Busey (to U. S. Atomic Energy Commission). U. S. Patent 3,132,997. May 12, 1964).

This invention relates to a nuclear reactor in which the fuel is uranium or plutonium oxide in particulate form so that the particles form a settled slurry or paste. The slurry is circulated within a reactor vessel by a jet pump using sodium as the immiscible liquid. While the sodium pumps the slurry fission heat is transferred to it from the slurry. Centrifugal means are used to separate the slurry and sodium. The slurry stays within the reactor vessel to be re-circulated while the sodium is drawn off to a heat exchanger. (AEC)

## Power and Power-Breeder Reactors

**23052** (CONF-504-2) BORAX V—A NUCLEAR SUPERHEAT REACTOR. R. E. Rice and W. R. Wallin (Argonne National Lab., Idaho Falls, Idaho). [1963]. Contract W-31-109-eng-38. 21p.

From American Power Conference 26th Annual Meeting, Chicago, Apr. 1964.

The advantages and difficulties of the nuclear superheat concept, particularly the integral boiling-superheating reactor, are discussed; and the BORAX V facility is described. Three core configurations were provided: a boiling-water core with a centrally located superheater, a boiling core with a peripherally located superheater, and a pure boiling core. Initial operation was with a pure boiling core (powers up to 20.5 Mw thermal). The central superheater core was then operated successfully, but briefly, at powers up to 10.2 Mw thermal. Results of measurements are included. (D.C.W.)

**23053** (DLCS-5000264) MONTHLY OPERATING REPORT, FEBRUARY 1964. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 53p.

The end of Seed 4 lifetime operation and reactor output with Core 1 was terminated, when the reactor coolant temperature decreased to 465°F. During the shutdown period, low power physics tests were performed, the decontamination facility was tested, blanket fuel elements were removed from the reactor, and a mock run of the decontamination system was conducted. Decontamination of the reactor coolant system was initiated. One incident occurred during the low power physics testing which involved the momentary unlatching of a control rod during a power supply transfer. Reference water conditions were maintained during the operating period in the reactor coolant system, the reactor plant auxiliary systems, and in the operating boilers. There was a noticeable decrease in the reactor coolant system pH following the interconnection to the decontamination system. However, a further decrease of the pH was prevented by chemical treatment. A refueling sequence change involved the removal and replacement of selected blanket fuel assemblies which was accomplished prior to the initiation of the decontamination process. Training, procedure preparation, trial fit of Core 2 tooling and inspection continued. Twenty tests were performed. Construction on the decontamination system was completed. (auth)

**23054** (GEAP-4432) EVESR-NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. Quarterly Report No. 6, September–November 1963. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Dec. 1963. Contract AT(04-3)-189. 79p.

All construction activities at the EVESR site were completed. Acceptance testing of the basic plant systems is complete, and the combined systems operational acceptance test was successfully completed. The EVESR operating license was made effective. The first four bundles of fuel were loaded. Flooding and unflooding tests were conducted to confirm that all water is blown from the steam coolant passages in the fuel by incoming saturated steam. Following the unflooding tests, fuel loading continued and initial criticality was achieved, with sixteen fuel bundles in the core. A seventeenth fuel bundle was loaded to provide additional reactivity and the critical testing program was initiated. Preliminary measurements of the reactivity effect of flooding and unflooding the fuel were made using a fuel bundle specially adapted for controlled flooding and unflooding. Results appear consistent with calculations. Complete core loading with 32 fuel bundles was achieved. The installation of instrumentation in the EVESR containment building is complete. This includes temperature, pressure, and flow sensors in the superheated steam pipes which lead from the reactor as well as the associated piping, signal transducers, transmitters, and electric cables. The installation of the sample lines and sample stations which make up the coolant chemistry sampling system is complete. The instruments have been installed in the sample stations. The design has been completed and procurement is in progress for an isothermal corrosion test facility. This autoclave unit will be installed in a bypass in the divert steam header and will be used for conducting fuel materials corrosion tests in a superheated steam atmosphere. The mechanical design of Mark III fuel is proceeding. The design features of the Mark III fuel are as follows: the fuel bundles will contain four clusters of seven rods each; the clusters will be contained in two Zircaloy hairpin tubes through which steam will flow; the Zircaloy U tubes will be thermally insulated from superheated steam temperatures by an Incoloy or stainless steel liner; the rod clusters will be removable for examination; and fuel cladding will be made of Incoloy and will have thicknesses of 0.020, 0.016, 0.012, and 0.008 inch. (auth)

**23055** (GEAP-4607) DEVELOPMENT PROGRAM ON THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 6. C. L. Howard (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 1, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 12p. (EURAEC-1028)

A report, "Reactor Pressure Vessel Material Surveillance Program at the Garigliano Nuclear Power Plant," GEAP-4423, is summarized. Initial test of the on-line power distribution calculations is complete. The computer code converges rapidly and gives radial power distributions in satisfactory agreement with values measured by gamma scan of the Garigliano fuel. (auth)

**23056** (GEST-2030) RESEARCH PROGRAM FOR THE LONG-TERM TESTING OF CYLINDRICAL DIODES AND THE RADIATION OF FUEL AND INSULATOR. Quarterly

Progress Report, September 18, 1963–December 17, 1963. (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Contract NAS-3-2544. 100p.

Development work on the STAR-C (Space Thermionic Auxiliary Reactor) is reported. Three thermionic converters were fabricated, assembled, and placed on test. The configurations of the components and subassemblies are described. $UO_2$ clad with W–26% Re is being tested in a cesium environment, a vacuum environment, and in a radiation environment. Equipment is being prepared for irradiation of aluminum oxide in the NASA Plum Brook Reactor. (M.C.G.)

**23057** (HW-79921) TESTING OF PRCF LIGHT WATER MODERATOR CONTROL AND REFLECTOR RODS—PROJECT CGH-999. W. S. Kelly (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 19, 1963. Contract AT(45-1)-1350. 24p.

Drop tests of control and reflector rods were made in water and in air, and drop time were measured using a clock timer and a Brush record. Copies of the data sheets showing test results and any required changes or adjustments are presented for each rod. (L.B.S.)

**23058** (HW-80829) PRTR SECONDARY ACTIVITY DETECTION SYSTEM. Engineering Review. E. M. Davis (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 12, 1964. Contract AT(45-1)-1350. 9p.

The detection system uses five scintillation tubes to measure the gamma activity of water entering and leaving the four heat exchangers of the secondary coolant system, thereby detecting leaks. The system is described, and operating experience is summarized. Notably, the background in the area of the detectors masks the low-level count rate expected from small leaks. Recommendations for improving detection (including detector relocation) are made. (D.C.W.)

**23059** (NAA-SR-6387) OPTICAL, LIGHTING, AND PHOTOGRAPHIC EQUIPMENT FOR THE SRE RECOVERY PROGRAM. E. R. Meise (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 15, 1964. Contract AT(11-1)-Gen-8. 51p.

A general description and pictures of the numerous optical devices, special lights, and photographic equipment used in the successful moderator and fuel replacement program at the Sodium Reactor Experiment are presented. The optical devices, designed to operate at 400°F, were gas tight, and varied in length from 3 to 30 ft. (auth)

**23060** (NYO-10600) PM-1 PROJECT COMPLETION REPORT. Henry A. Sindt (New York Operations Office, AEC). Feb. 1964. 178p.

The actual construction of the PM-1 power plant is summarized, together with the test operations at the site. Design, fabrication and assembly, preshipment testing, and shipment are covered in even less detail. An analysis of project costs is also provided. The difficulties encountered are indicated, and suggestions for avoiding them are included. Plant characteristics and parameters are tabulated; and project objectives, achievements, organization, and administration are discussed. (D.C.W.)

**23061** (ORNL-3591(p.217-22)) SNAP-8 CHEMISTRY STUDIES: THE CHEMISTRY OF HYDROGEN–NaK SYSTEMS. E. L. Compere, J. E. Savolainen, H. C. Savage, and T. H. Mauney (Oak Ridge National Lab., Tenn.).

The fate of the hydrogen entering the circulating NaK of the SNAP-8 reactor primary coolant circuit from the zirconium–uranium hydride fuel elements depends on the rates of hydrogen diffusion through the primary system walls and on factors governing hydrogen solubility in NaK. Data on such phenomena are important to the operation of the system. The diffusion of hydrogen through metal walls in upstream contact with NaK might differ from diffusion of the gas in the absence of NaK. Measurements of the effect of diffusion rates were initiated. Reasonable permeability values for Hastelloy N (INOR-8) were obtained at temperatures up to 550°C. No particular effect of NaK was evident at these temperatures. An apparatus for the determination of the solubility of hydrogen in NaK at low pressures was designed and fabricated. (auth)

**23062** (ORNL-TM-847) THE MERC-1 EQUILIBRIUM REACTOR CODE. T. W. Kerlin, Jr., C. W. Craven, Jr., L. G. Alexander, and J. L. Lucius (Oak Ridge National Lab., Tenn.). Apr. 22, 1964. Contract W-7405-eng-26. 46p.

MERC-1 is a code that calculates the neutronic and economic performance of fluid-fuel reactors on the basis of the equilibrium condition and multigroup, one-dimensional diffusion theory. Equilibrium is that condition in which the time rate of change of all nuclide densities is zero because of a balance between gains (feed, recycle, nuclear transmutation, and radioactive decay) and losses (discharge, nuclear transmutation, and radioactive decay). The space, energy, and time dependence are treated by synthesis of results from a space-energy calculation, and a time-dependent (equilibrium) calculation. The main links in MERC-1 are MODRIC (a one-dimensional, multigroup neutron diffusion code) and ERC-10 (a code which calculates equilibrium reactor composition and fuel cycle economics). (auth)

**23063** (TID-7662(p.91-135)) THE INTERPRETATION OF BOILING-WATER-REACTOR STABILITY DATA. J. M. Case (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

A comprehensive stability test was conducted in the Vallecitos Boiling Water Reactor. The overall objective was to make the analysis of stability a working technology by which the designer can specify the system requirements necessary for adequate stability in any proposed boiling-water reactor. The experimental-data analysis and interpretation phase are discussed. The primary parameters measured during the tests were total core power, in-core fluxes, total recirculation coolant flow, and individual fuel-element coolant flows. Various combinations of reactor power, recirculation flow rate, and recirculation flow restraint were examined during the test series. In addition to forced-circulation conditions, the reactor was also operated in natural circulation, allowing convection within the reactor vessel. Two primary types of test data were collected: rod-oscillator data and steady-state operating-noise measurements. Information gathered from the rod-oscillator test data included rod worths of reactivity, total power reactivity feedback gains, void coefficients of reactivity, and gain and phase margins of stability. It was found that in the case of the VBWR peak-to-peak flux noise measurements not only fail to indicate a trend toward unstable operation, but, even worse, indicate the reverse trend. Resonant two-phase hydrodynamics at 0.4 to 0.5 cycle/sec were exhibited within the reactor core during natural circulation. This flow resonance was displayed two ways; first, by observation of an instrumented fuel-assembly turbine flow meter; and, second, by the existence of a characteristic dip in the power transfer function for this test. (auth)

**23064** (TID-7662(p.299-316)) CALCULATIONAL PROCEDURES FOR EVALUATING TRANSIENTS IN SEMIHOMOGENEOUS POWER REACTORS. M. H. Merrill (General Atomic Div. General Dynamics Corp., San Diego, Calif.).

The coupled kinetics-heat-transfer program developed for evaluating transient characteristics of the Peach Bottom Power Reactor is described. Data are presented for the reference design of the HTGR core. The negative temperature coefficient is enhanced by the use of rhodium poison. Calculations performed for a rod-fall accident are briefly described. (C.E.S.)

**23065** (TID-7662(p.405-18)) THE STEADY-STATE AND TRANSIENT KINETICS OF THE EBR-I, MK-III. J. C. Carter, D. W. Sparks, and J. H. Tessier (Argonne National Lab., Ill.).

The dynamic behavior of the EBR-I, Mk-III, is examined with the objective of providing an explanation of the dynamic behavior of the major inherent reactivity feedback sources that exist in this particular fast reactor. The analysis begins with the reduction of measured test data, which shows that the feedback function contains a significant nonlinearity. From consideration of structural features of the reactor, it is postulated that the observed nonlinearity arises from the restraint imposed on the free thermal expansion of the core by frictional forces that exist between adjacent fuel rods. A mathematical model of the restrained thermal expansion is presented, and model and reactor responses are compared. Stability of the reactor under power-equilibrium conditions is assessed through linear extrapolation of test data and through consideration of the describing function for the nonlinear thermal expansion. The influence of positive reactivity on stability is examined through use of a root-locus family, which shows the location of the dominant complex roots of the incremental linear-equivalent system function for various values of excess reactivity and power. (auth)

**23066** (TID-20019) BOILING NUCLEAR SUPERHEATER (BONUS) POWER STATION TECHNICAL SPECIFICATIONS. Appendix A. (Division of Licensing and Regulation, AEC). [1962]. 125p.

Supersedes GNEC-214.

Specifications are given for the site, coolant system, containment, pressure control system, core design, core heat transfer, control and safety systems, monitoring systems, waste disposal systems, auxiliary systems, ventilation, and fuel transfer and storage in the BONUS Reactor. (C.E.S.)

**23067** (WCAP-6061) YANKEE CORE EVALUATION PROGRAM. Semi-Annual Progress Report for the Period Ending March 31, 1964. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Apr. 1964. Contract AT(30-1)-3017. 148p.

A fuel assembly irradiated in Yankee Cores I and II to an average burnup of approximately 21,000 MWD/MTU was examined. In general, the extended-burnup assembly appears clean, essentially free of "crud", and shows no anomalies attributable to irradiation or significant dimensional changes. Hot cell data are given on ten Yankee Core I fuel rods. Fission gas release data, metallographic results, and microhardness data are given. There were no significant dimensional changes noted in the fuel rods, and no significant micro-structural changes in cladding, fuel, or joints. As anticipated, samples of irradiated cladding showed marked increases in hardness. Isotopic analyses performed on eight "crosscheck" samples by each of three laboratories show significant discrepancies between laboratories. Progress is being made on the resolution of these anomalies. The sampling plans have been revised to reflect results obtained. (auth)

**23068** (ANL-Trans-13) FORTRAN PROGRAM FOR THE MINIMIZATION OF AN n-VARIABLE FUNCTION. J. Rognon (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). Translated by Rita R. Inston (Argonne National Lab., Ill.), from report TM-ST-18, July 31, 1963. 25p.

The development of a FORTRAN program for minimization of an n-variable function for calculating the cost price of the kwh of a reactor is described. (C.E.S.)

**23069** (EURAEC-730) IMPROVEMENT OF HEAT TRANSFER IN BOILING WATER REACTORS. Quarterly Report No. 13, April–June 1963. C. Moussez (Société Nationale d'Etude et de Construction de Moteurs d'Aviation. Division Atomiques, Suresnes, France). July 17, 1963. Work performed under United States–Euratom Joint Research and Development Program. 11p. (A translation)

The thermal-hydraulic and neutronic properties of reactor fuel elements with spin strips are measured. The characteristics of a SENN-type reactor containing these fuel elements are examined. (T.F.H.)

**23070** THE NUCLEAR POWER PLANT AT KAHL IN SERVICE FOR TWO YEARS. A. Weckesser and F. Meyer. Energie Nucl., 6: 18-28(Jan.-Feb. 1964). (In French)

The plant, which uses a boiling water reactor (60.4 Mw thermal), is briefly described; and its construction, start-up, testing, measurements, and increase to full power are outlined. The results of observations over the two years of operation on the reactivity distribution in the core, start-up, the consequences of scrams, radiation levels, and availability are presented. (D.C.W.)

**23071** CONCEPTUAL DESIGN OF A POWER STATION USING A (EXPERIMENTAL) SEMIHOMOGENEOUS HIGH-TEMPERATURE GAS COOLED REACTOR. FAPIG (Tokyo), 27: No. 2, 91-120(Aug. 1963). (In Japanese)

A nuclear power station using an experimental semihomogeneous high-temperature gas-cooled reactor is described. The power station is characterized by the direct connection of its primary cooling system and gas turbine. Efforts are made to minimize the amounts of fission products escaping from fuel elements and to maintain contamination in the primary cooling system at very low levels. The fuel element is prepared as follows: $UC_2$ particles coated with unpermeable carbon are dispersed in a graphite matrix, which is sheathed double with impervious graphite. Design criteria include the following: thermal output, 31 Mw; electric output 11.2 Mw; net electric output, 9.9 Mw; core, 130 cm$\phi$ × 150 cmH; coolant, helium (30 kg/cm$^2$); inlet coolant temp., 488°C; outlet coolant temp., 754°C; fuel element, $UC_2$(200$\mu$); number of fuel elements, 400; dimensions of the fuel element, 6.0 cm OD × 150 cm; max. fuel temp., 1425°C; thermal neutron flux, $5.15 \times 10^{13}$ (ave.); pressure vessel, 444 cm$\phi$ × 1180 cmH × 7.0 cm th; gas turbine, axial flow, 8 stages, 14,000 rpm. Described are the nuclear design, reactor structure, and auxiliary facilities, fuel element and fission product containment, and control and safety. (Nucl. Sci. Abstracts of Japan, 3: No. 2, (Apr. 1964))

**23072** NOTES ON NUCLEAR POWER STATION POSITION PLANNING. D. Ufer. Kernenergie, 7: 163-6(Mar. 1964). (In German)

Criteria for optimum site location of atomic power plants are discussed. The principal considerations are safety, water supply, and economic factors. The relative

significances of these considerations vary with advances in nuclear technology; for example, safety is no longer as important as it was before since the principal potential dangers were eliminated or reduced to a large extent. Currently, the economic factors are in the forefront. It is important to locate the power plant so that it contributes optimally to the existing power network and that it is capable of serving present and potential power consumers. Determination of optimum size is essential. Differences between criteria for positioning atomic and conventional power plants are also discussed. (P.C.H.)

**23073** NUCLEAR POWER AND THE PRE-INVESTMENT STUDY. Pedro G. Afable (Philippine Atomic Energy Commission, Manila). Sci. Rev. (Manila), 4: 32-40 (Sept. 1963).

A proposed pre-investment study for determining the technical feasibility and economic advantage for the Philippines to utilize nuclear power during 1965-1975 to meet part of its growing need for electric power is outlined. (C.E.S.)

**23074** BUILDING THE CAISSONS OF THE E.D.F. 1 AND E.D.F. 2 REACTORS AT CHINON. G. Lamiral (Electricité de France, Clamart) and R. Leclerc. Soudage Tech. Connexes, 16: 433-47(Nov.-Dec. 1962). (In French)

These caissons, in manganese-molybdenum steel, were first welded using X-form welding techniques, with local alternating pre-heating. However, owing to the appearance of a 10 m crack, a new working method was subsequently adopted, using V-joints and general unilateral pre-heating. For E.D.F. 2, the joints were welded using automatic welding techniques with flux, thanks to a special handling device. (auth)

**23075** THE FUEL CYCLE FOR LIGHT-WATER MODERATED REACTORS. A. Persson. Tek. Tidskr., 94: 85-8(1964). (In Swedish)

Evaluating various reactor types for power production in Sweden, it appears that the light-water reactor has advantages as well as disadvantages compared with the heavy-water reactor. The disadvantages are mainly that enriched fuel becomes necessary and that the fuel cycle becomes more costly. A combination of both light- and heavy-water reactors may offer the best solution for Sweden's future power production problems. (auth)

**23076** HEAT EXCHANGERS IN NUCLEAR POWER PLANTS. George T. Lewis, Jr., Michael Zizza, and Paul DeRienzo (Burns and Roe, Inc., New York). p.41-106 of "Advances in Nuclear Science and Technology. Vol. 2." New York, Academic Press, 1964.

Types and configurations of heat exchangers, performance and reliability design considerations, and cost criteria are discussed. (R.E.U.)

**23077** NUCLEAR POWER SYSTEMS. AN INTRODUCTORY TEXT. C. D. Gregg King. New York, The Macmillan Co., 1964. 493p. $13.00.

The fundamental scientific and engineering principles upon which the design of power-producing reactors are based are discussed. Topics covered include nuclear physics, neutrons, fission, reactor physics, reactor transient behavior, reactor control and plant dynamics, reactor shielding, materials, and reactor types. The thermodynamics of nuclear power plants is discussed; steam turbines, fluid mechanics, and heat transfer are considered. (R.E.U.)

**23078** IMPROVEMENTS RELATING TO GAS-COOLED NUCLEAR REACTORS. (to the City of Dusseldorf). British Patent 957,293. May 6, 1964. Priority date May 30, 1962, Germany.

A design is presented for a multi-vessel gas-cooled power reactor whose coolant is heated above 600°C by passing over a "closed-circuit" core. The coolant then passes through a primary heat exchanger in the reactor vessel, and then through a secondary heat exchanger in a secondary vessel. (T.F.H.)

**23079** NUCLEAR REACTORS. (to Sulzer Freres Societe Anonyme). British Patent 957,956. May 6, 1964. Priority date Feb. 27, 1960, Switzerland.

The design of a multi-zone, superheated-vapor-cooled reactor is described. Throttling arrangements are provided for controlling the flows and inlet and outlet temperatures of the coolant in each zone. The design is compatible with the use of steam as the coolant vapor. (T.F.H.)

**23080** PRECIPITATOR MONITOR FOR NUCLEAR POWER PLANTS. Winfried Eming and H. Peter Sterman (to Deutsche Babcock and Wilcox-Dampfkesselwerke AG). German Patent 1,158,191. Nov. 28, 1963. Filed May 15, 1962.

The fission product detecting device described comprises a precipitation chamber, a scintillation counter arranged external to the chamber adjacent to one end thereof, and a collector electrode, e.g., a wire, extending through the ends of the chamber, which is moved in front of the counter. To prevent radioactive gas diffusion from the precipitation chamber to the scintillation counter, nonradioactive gas can be fed in a closed circuit passed the scintillation counter and through the precipitation chamber. The direction of flow of the nonradioactive gas is opposite to the direction of motion of the wire electrode. (Gmelin Inst.)

**23081** CONTROL OF SINGLE CYCLE POWER SYSTEM HAVING A STEAM GENERATING REACTOR. Robert E. Kuerzel (to General Electric Co.). U. S. Patent 3,128,233. Apr. 7, 1964. Filed Aug. 7, 1961.

A single cycle power system control means is designed for rapidly varying the motive fluid output from the motive fluid generator in response to system load changes. Upon load changes, the position of one or more control rods is changed to provide a relatively long term reactor power level change, and instantaneous changes in steam flow are effected by pressure changes on the body of boiling water in the reactor system. Means are provided for preventing excessive pressure changes in the reactor. A feedback means resets the prescribed limits within which the base pressure may be adjusted after the relatively long-term power level change has been completed. The control system includes an overspeed responsive means for overriding the pressure sensitive and responsive means in the event of a substantial turbine speed increase. (A.G.W.)

## Process Heat Reactors

**23082** (CONF-393-5) PIPELINE GAS FROM COAL USING NUCLEAR HEAT: A TECHNICAL AND ECONOMIC EVALUATION. L. J. Pieroni, R. P. Griffin, W. H. Heffner, and G. T. Skaperdas (Kellogg (M. W.) Co., New York). [1963]. Contract AT(30-1)-3009(2). 42p.

From American Institute of Chemical Engineers Symposium on Techniques at High Pressures, Memphis, Feb. 1964.

The results of a technical and economic evaluation of the utilization of nuclear heat to gasify lignite and bituminous coal and produce 915-Btu pipeline gas are reported.

Heat is transferred from a high-temperature, gas-cooled nuclear reactor to the solid-fuel gasification plant by a stream of 435-psig helium heated to a maximum temperature of 2500°F. There is no in-reactor processing involved, hence radioactivity in the processing plant is assumed to be negligible. It was concluded that the gasification may be carried out more economically in a fluidized bed containing immersed heat-transfer tubes than in either a fixed-bed or an entrained-bed gasifier. Excluding the nuclear reactor, total capital investment to produce 90,000,000 standard cubic feet of pipeline gas per day from lignite is about $45,000,000; from bituminous coal, about $70,000,000. If nuclear heat costs 50 cents per million Btu, pipeline gas can be produced from $2 per ton lignite for about 62 cents per thousand standard cubic feet; from $5 per ton bituminous coal for about 94 cents per thousand standard cubic feet. (auth)

**23083** DISTRICT HEATING. PART IV. DISTRICT HEATING BY MEANS OF NUCLEAR POWER. R. M. E. Diamant. Heating Ventilating Engr., 36: 556-63(Apr. 1963).

The feasibility of multiple-dwelling heating by a centrally located nuclear power plant is discussed. The Agesta reactor located in Farsta, near Stockholm, is described. (R.E.U.)

## Production Reactors

**23084** (HW-SA-3453) A RELIABILITY STUDY OF A NUCLEAR REACTOR PRESSURE MONITOR COINCIDENCE TRIP SYSTEM. Jimmie Griff Parsons (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 31, 1964. Contract AT(45-1)-1350. 59p.

Thesis submitted to Univ. of Washington, Seattle.

A reliability study of the recently-installed Pressure Monitor Coincidence Trip System at the Hanford KE and KW Reactors is presented. Water flow to each process tube is monitored by the system and it provides the primary safety feature for reactor protection. The system is comprised of 3200 pressure transducers and a 232 relay logic network for each reactor. Data and assumptions are correlated to provide approximate reliability figures for the electrical and mechanical component parts of the pressure monitor system. Each component is analyzed in a manner that will be applicable to future system studies. Additional features of the system, such as trip coordinate identification, dual power feeds, ground detection, and test and ground switches, are discussed in detail. (auth)

## Propulsion and Space

**23085** (SC-DR-285-63) ENVIRONMENTAL TESTING OF THE SNAP-10A SAFETY FLIGHT VEHICLE. D. L. Krenz (Sandia Lab., Albuquerque, N. Mex.). Jan. 1964. Contract AT(29-1)-789. 20p.

The environmental testing of the SNAP-10A safety flight vehicle is reported. The environments, test parameters, and testing techniques are discussed. (auth)

**23086** (TID-7662(p.501-27)) CONTROL OF TORY II-C NUCLEAR RAMJET ENGINE. E. E. Alexander, R. B. Hollstien, E. A. Sheridan, and R. G. Staker (California. Univ., Livermore. Lawrence Radiation Lab.).

Control requirements and configuration of the nuclear control system are described. System design considerations are discussed, and a controller is described that limits the positive inverse period during normal control responses. The control-rod servosystems must operate at temperatures over 1000°F in the reactor inlet air duct; the frequency-response method is applied to show the effect of the dynamic response of the vernier-rod servosystem on the stability margin of the power control. Samples of analog-computer studies are included to illustrate the performance characteristics of the complete system. (auth)

**23087** (UCRL-13097(Vol.I)) TORY IIC PROTOTYPE SERVO ACTUATOR SYSTEM. VOLUME I. Final Technical Report, April 1, 1962–September 30, 1963. Report No. 2521. (Bendix Corp. Research Labs. Div., Southfield, Mich.). For California. Univ., Livermore. Lawrence Radiation Lab. Contract AT(29-2)-705. 245p.

Environmental testing of the prototype electropneumatic servo system used as a control-rod actuator and drive for the Tory IIC reactor is reported. Volume I deals with the development of a linear transducer, and leakage reduction and reliability testing results for the upgraded prototype servo motor. (T.F.H.)

**23088** (UCRL-13097(Vol.II)) DESIGN OF TORY IIC VERNIER AND SHIM ACTUATOR SYSTEMS. VOLUME II. Final Technical Report, April 1, 1962–September 30, 1963. Report No. 2521. (Bendix Corp. Research Labs., Div., Southfield, Mich.). For California. Univ., Livermore. Lawrence Radiation Lab. Contract AT(29-1)-705. 181p.

Environmental testing of the prototype electropneumatic servo system used as a control-rod actuator and drive for the Tory IIC reactor is reported. Volume II deals with additional endurance testing for the servo motor, combined environmental and reliability testing of torque motor coils for the electropneumatic servo valves, and the investigation and elimination of malfunction of servo valves caused by a temperature differential between supply gas and body. (T.F.H.)

**23089** (UCRL-13097(Vol.III)) TORY IIC PROTOTYPE SERVO ACTUATOR SYSTEM. VOLUME III. Final Technical Report, April 1, 1962–September 30, 1963. Report No. 2521. (Bendix Corp. Research Labs. Div., Southfield, Mich.). For California. Univ., Livermore. Lawrence Radiation Lab. Contract AT(29-2)-705. 193p.

Environmental testing of the prototype electropneumatic servo system used as a control-rod actuator and drive for the Tory IIC reactor is reported. Volume III deals with the investigation of servo valve operation under transient supply gas and ambient gas temperature conditions, engineering and test evaluation for the prototype rack-and-pinion drive, the prototype finned-tube heat exchanger, and an improvement of the Tory IIC clutch. (T.F.H.)

**23090** RESEARCH ON THE COLLISION-RESISTING CONSTRUCTION OF THE SIDES OF A NUCLEAR POWERED SHIP. REPORT NO. 3. H. Oi, T. Harima, H. Lizuka, G. Kataoka. Mitsubishi Nippon Jukogyo Giho, 4: 145-55 (1963). (In Japanese)

Experiments on collision were carried out on five types of ship side construction models, the dimensions of which were of about $\frac{1}{15}$ of the collision-resisting compartment of the Nuclear Powered Oceanographic Research and Tender Ship, subjected to both statical and impact loading at the center of them. The relation between energy absorption and deformation of the ship side construction, mechanism of destruction of bow and side construction, and how to predict the deformation of ship side construction at collision, were outlined. (auth)

**23091** PROJECT FOR A NUCLEAR-ELECTRIC PAYLOAD TRANSPORTER. G. F. Au. Raumfahrtforschung, 8: 38-40(Jan.-Mar. 1964). (In German)

A space vehicle with a gas-cooled reactor having tur-

boelectric energy conversion and electrostatic ion drive is described. Design of the space vehicle, two mission examples, insertion possibilities of the space vehicle, electric drive, position stabilization system, control system, electronics, steering, and possibilities for further development are discussed. (M.C.G.)

**23092** A NUCLEAR-POWER TANKER. Wolfgang Braun and Karl-Heinz Otte. Siemens Rev., 30: 435-8 (1963).

Some design considerations for a pressurized-water reactor (3.5 tons of $UO_2$ enriched to 4%) for an ocean-going tanker with a capacity of 47,500 tdw are discussed. The feasibility study was commissioned by the German Federal Ministry of Atomic Energy and Water Economy in 1960. Some scale models are shown. (R.E.U.)

**23093** SNAP HIGH-TEMPERATURE MATERIALS PROBLEMS. J. D. Watrous and J. R. Wetch (Atomics International, Canoga Park, Calif.). p.60-72 of "Materials and Fuels for High-Temperature Nuclear Energy Applications." Cambridge, Mass., The M.I.T. Press, 1964.

Problems created by the long-life high-temperature operation of SNAP reactors are discussed. (R.E.U.)

**23094** ANALYSIS OF A MEGAWATT LEVEL DIRECT CONDENSER-RADIATOR. Richard P. Krebs, David M. Winch, and Seymour Lieblein (Lewis Research Center, Cleveland). p.475-504 of "Power Systems for Space Flight." New York, Academic Press, 1963.

An analytical study of a nonredundant direct condensing finned-tube radiator for a 1-Mw Rankine electrical power generating system shows that the radiator weight may be close to 6000 lb. This radiator was assumed to use beryllium fins and armor over a niobium alloy tube liner. Protection against damage from meteoroid impact, for the criteria used, constituted the major portion of the total weight. The study indicates the effect of tube diameter, number of tubes, and segmentation into nonredundant panels on the radiator weight and pressure drops. Header weights are of such magnitude that they should be considered in radiator design and analysis. Application of nonredundant segmentation results in some weight saving. (auth)

**23095** SPUR HIGH-TEMPERATURE SPACE RADIATOR. Keneth O. Parker and Robert A. Stone (AiResearch Mfg. Co., Los Angeles). p.505-33 of "Power Systems for Space Flight." New York, Academic Press, 1963.

The results of a design study of the Spur radiator are presented. Factors affecting the choice of materials and fabrication procedures are discussed, and the requirements imposed on the radiator by the rest of the system are described. The results of parametric studies that show the effect on the radiator of the important design variables are given. A reference design of a 350-kw(e) system radiator is described in detail. It is made entirely of niobium–1% zirconium alloy and weighs 5 lb/kw(e), with an area of 1.5 $ft^2$/kw(e) for the condenser section and $\frac{1}{2}$ $ft^2$/kw(e) for the subcooler. The weight includes manifolds and structure to support the reactor and shield, and is based on what is believed to be a reasonable system of meteoroid parameters. (auth)

## Research and Test Reactors

**23096** (CURL-2) FINAL SAFEGUARDS REPORT TO THE U. S. ATOMIC ENERGY COMMISSION FOR THE CORNELL UNIVERSITY TRIGA REACTOR. David D. Clark (Cornell Univ., Ithaca, N. Y.). May 1961. 133p.

The Cornell TRIGA reactor uses the TRIGA core with pulsing fuel-moderator elements. The reactor is designed for steady-state operation at a power level of 100 kw and for routine pulsed operation. The reactor, site and building, and other facilities in the reactor building are described; and the results of a hazards analysis are presented. Plans for utilization of the reactor are outlined, and the administrative and safety procedures are discussed. (auth)

**23097** (IDO-16958) RESULTS OF ATR SAMPLE FUEL PLATE IRRADIATION EXPERIMENT. M. J. Graber, G. W. Gibson, V. A. Walker, and W. C. Francis (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Mar. 23, 1964. Contract AT(10-1)-205. 62p.

Fuel materials proposed for use in the Advanced Test Reactor were evaluated. Aluminum alloy (X8001) cermet cores with $UO_2$, $U_3O_8$, or $UAl_3$ dispersants clad with either 6061-O or X8001 were irradiated in the Engineering Test Reactor at simulated Advanced Test Reactor conditions. Fabrication methods, test parameters, pre-irradiation and post-irradiation examinations are discussed. A core failure mechanism which produced blistering in the uranium oxide compositions was not detectable in the intermetallic compositions. (auth)

**23098** (KN-63-685-11) PRELIMINARY HAZARDS SUMMARY REPORT FOR THE MoLLY-G REACTOR. Kay B. Carver (Kaman Aircraft Corp. Kaman Nuclear Div., Colorado Springs). May 22, 1963. Contract DA-29-040-ORD-2919. 84p.

The Bare Critical Assembly, MoLLY-G, is a prompt-critical reactor designed to simulate the radiation environments of nuclear detonations. The maximum output of the assembly is rated at $2 \times 10^{17}$ fissions per burst, with as little as one hour elapsed time between bursts. The MoLLY-G can also be operated at 10 kilowatts steady-state power for short periods. The potential hazard to the general public is essentially zero under all conceivable circumstances, including the maximum credible accident. When operated in accordance with prescribed safety regulations, standards and codes, there is no hazard to the operating and using personnel. Maximum safety was provided in all areas of potential hazard. Safety features include: radiation shielding, interlocks, controlled access, remote viewing, remote control, and fail-safe provisions in performing components. Based upon the analysis of this hazards report, the MoLLY-G can be operated safely as a part of the Nuclear Effects Laboratory Facility. The reactor, reactor site, and reactor facility are described; and administrative and procedural safeguards are discussed, together with hazards. (auth)

**23099** (ORNL-3591(p.156-9)) SPECIAL STUDIES FOR GAS-COOLED REACTOR PROGRAM. (Oak Ridge National Lab., Tenn.).

The neutron flux spectra of the ORR B-9 core position and P-06 poolside irradiation facility were measured. Bare cobalt was used as the thermal flux monitor; cobalt clad in a 40-mil thickness of cadmium was used as the resonance flux monitor; $^{237}Np$ and nickel, each clad in a 40-mil thickness of cadmium, were used as threshold detectors for the fast flux. The neutron flux above 0.18 Mev was calculated from the nickel and neptunium measurements on the assumptions that all the slowing down is due to hydrogen and that the reactor is infinite and homogeneous. Twenty-five metals were tested for thermoelectric stability under PBRE conditions. Metals exhibiting 2% or less error in their output against platinum at 420°C after exposure for 141 days at 982°C were Chromel-P, Special Chromel-P, Ni–18Mo, Geminol-N, and Special Alumel. The radiation stability of $CF_4$ in prefluorinated nickel cells was invest-

gated. Radiolytic products were $F_2$, $C_2F_4$, and $COF_2$ with ratios of the latter two dependent on trace oxygen content. A literature survey revealed that $SO_2$ has a high thermal stability, reacts extensively with graphite at high temperatures, and has not been investigated experimentally for radiolytic damage. (auth)

**23100** (SGAE-CH-2/1964) KAPSELN FUR DIE BESTRAHLUNG ORGANISCHER FLUSSIGKEITEN IM KERNREAKTOR BEI ERHOHTEN TEMPERATUREN. (Capsule for Irradiation of Organic Liquids in Nuclear Reactors at High Temperatures). E. Proksch, H. Bildstein, and F. Wiesinger (Österreichische Studiengesellschaft fiir Atomenergie G.m.b.H., Vienna). [1964]. 12p.

The construction of a simple irradiation capsule is described and operating experiences with this capsule are reported. The temperatures obtained in the core of a swimming-pool reactor at powers of 1 to 2 Mw for this capsule were between about 150 and 350°C. They can be held constant to within one degree. (tr-auth)

**23101** (SGAE-CH-3/1964) KALORIMETRISCHE DOSISLEISTUNGSMESSUNGEN IM CORE DES ASTRA-REAKTORS. (Calorimetric Dosimetry Measurements in the Core of ASTRA Reactor). E. Proksch, H. Bildstein, and F. Wiesinger (Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Vienna). [1964]. 27p.

In the irradiation of organic liquids in the core of the ASTRA reactor, the radiation dose absorbed by each sample was determined, with the help of additional flux monitors, by calorimetric dose rate measurements. This calorimetry was carried out according to a simple quasi-adiabatic method. By a careful evaluation, an accuracy was attainable, which was comparable with that obtained at much greater expense by adiabatic measurements. By measurement with various combined calorimeters the part of the total dose due to absorption of gamma radiation and the slowing down of fast neutrons was determined mathematically. (tr-auth)

**23102** (TID-7662(p.150-68)) STABILITY MEASUREMENTS ON BORAX-V BOILING CORE B-2. R. A. Cushman, D. Mohr, R. N. Curran, and D. H. Brown (Argonne National Lab., Idaho Falls, Idaho).

Transfer-function measurements using the sine–cosine cross-correlation analog-computer technique were carried out on the boiling core B-2 of BORAX-V. Runs were made at 0, 5, 10, 15, and 16.5 Mw with a rotating poison oscillator inserted at two axial heights in the core. Analysis of results indicates that the B-2 boiling core is stable at a power in excess of the maximum plant power-dissipation capacity of 40 Mw. (auth)

**23103** (TID-7662(p.317-33)) SEMIANALYTICAL METHODS FOR THE ANALYSIS OF REACTOR TRANSIENTS. F. T. Adler, Karl Hornyik, and Alan Baxter (Illinois. Univ., Urbana).

A set of integral parameters that provides good agreement between calculated and experimental values for flux and temperature response for a wide range of transient experiments was determined. In this model the variations with temperature of the specific heat and of the temperature coefficients must be taken into account. It appears that the space- and energy-dependent effects may only lead to minor corrections in the reactor response. The transients in a TRIGA reactor are considered. (C.E.S.)

**23104** (TID-7662(p.367-80)) COMPUTATIONS OF SPERT-III TRANSIENTS. C. Sastre and H. Kouts (Brookhaven National Lab., Upton, N. Y.).

The mathematical model used for computations of SPERT-III transients is described. The results and modifications to the model that were made to resolve some of the discrepancies are discussed. It was assumed that the kinetic behavior of the reactor could be described by a point reactor model. Only average temperatures in each medium and in each spatial region were considered. (C.E.S.)

**23105** (TID-7662(p.381-404)) TRANSIENT TEMPERATURE MEASUREMENTS IN REACTOR FUELS. M. E. Wyman, G. P. Beck, B. T. Chao, N. S. DeMuth, and P. K. Doshi (Illinois. Univ., Urbana).

Results of two types of experiments are reported: a method of determining the heat-deposition rate as a function of time and position during power transients and the phase relation of the reactor power and the fuel temperature during reactor oscillations. (auth)

**23106** (TID-7662(p.419-33)) KINETICS OF THE TRANSIENT REACTOR TEST FACILITY (TREAT). C. E. Dickerman (Argonne National Lab., Ill.).

Calculations were made of $k_{eff}$ as a function of temperature for a spherical reflected TREAT system using a 20-group representation and the $S_n$ approximation. One fast group covered the neutron energy range down to 2 ev. The heavy-gas model was used to calculate energy exchange between graphite and neutrons within the 19 thermal and near-thermal groups. In the analysis of TREAT kinetics, the shape of the resulting curve of temperature coefficient vs core temperature was taken as appropriate in the absence of an adequate crystalline model treatment. The absolute normalization was adjusted to fit the experimental data. (C.E.S.)

**23107** (TID-7662(p.434-46)) SOME SPECIAL FEATURES OF CONTROL PROBLEMS OF EXCURSION REACTORS. M. E. Thomas and W. E. Nyer (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

Generalized considerations with respect to reactivity control and how these considerations influence control systems are discussed. Reactivity-insertion rates and acceleration forces are considered. The control systems for the Power Burst Facility and the SNAPTRAN program are illustrated. (C.E.S.)

**23108** THE NEUTRON-FLUX-DISTRIBUTION IN AN EMPTY FUEL-ELEMENT-POSITION OF A POOL-REACTOR. W. Hammer and W. Koehler (Technische Hochschule, Munich). Atomkernenergie, 9: 93-8(Mar.-Apr. 1964). (In German)

For several experiments at the Research Reactor Munich (FRM) one fuel element was removed from the core gridplate and at that position an irradiation arrangement was put in. For this fuel element position the flux distribution was calculated with simplified assumption for two cases; filled with light water, and filled with air. The calculation according to the two group theory was compared with activation measurements. In the water-filled canal, thermal flux is greater by a factor of 3.7 than in the adjoining fuel elements. The epithermal flux is nearly the same, the fast flux is smaller by a factor of 0.55. When the irradiation facility is filled with air all fluxes are constant. By the remaining small water zone there is an ascent or a descent similar to the first arrangement. To compare the measured flux distribution with the calculated one, the measured flux was normalized in the center of the canal. There was good agreement in the thermal region, in the fast region on the other hand the calculated distribution within the fuel elements was smaller by 15% than the measured flux. A better agreement could be obtained by a diminution of the fast neutron diffusion coefficient. To give reason for the dimi-

nution a calculation was done. The result was $D_{IC} = 0.76 \pm 0.07$ cm. The distribution within the canal can be described by a Fermi-age of $27 \pm 1$ cm$^2$. (auth)

**23109** NRU REACTOR CONVERTS TO ENRICHED CORE. CONVERSION OF CHALK RIVER'S BIG RESEARCH REACTOR GIVES HIGH FLUX AT LOW COST. J. M. James (Atomic Energy of Canada, Ltd., Ont.). Can. Nucl. Technol., 3: 57-9(1964).

The change-over from natural uranium to enriched uranium in the NRU core is reported. The fuel rod design criteria and modifications to the reactor system are discussed. (R.E.U.)

**23110** ASSYMETRY EFFECT ON FUEL ELEMENT COOLING IN THE WWR-S REACTOR. Vladimír Zajíc (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 10: 71-6(1964). (In Czech.)

Analyses were made of fuel rod cooling in sections of the arrangement used for technological studies. On the basis of experimental results the influence of dislocation of fuel elements in the technological section, deformations caused by uneven cooling, and further consequences were evaluated. The results serve as a basis for prepared power increase for this type of reactor. (auth)

**23111** MEASUREMENT OF RADIOACTIVE WASTES VENTED BY THE AIR STACK OF THE VVR-S REACTOR IN THE PERIOD 1959-63. András Németh and Mihály Tóth. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 12: 25-41(1964). (In Hungarian)

The method for measuring the radioactive wastes vented at the air stack of the VVR-S reactor is described, and the results obtained are given. Results of investigations on the concentrations of radioactive dust particles in the atmosphere are also given. The results are used to estimate the airborne radioactivities to be expected around the reactor. (auth)

**23112** A MEASUREMENT OF THE EFFECTIVE DELAYED NEUTRON FRACTION FOR TTR-1. Kazuo Monta (Nippon Atomic Industrial Group Co., Japan) and Takao Mikami. Nippon Genshiryoku Gakkaishi, 6: 7-15(Jan. 1964). (In Japanese)

The effective delayed neutron fraction of TTR-1 was measured by the substitution technique. The poison plates were made of boron steel. The changes in reactivity produced by the substitution of a poison plate for a fuel plate were measured by means of a calibrated control blade. The sum of the reactivity changes associated with the substitution of all the fuel plates of the reactor was $\Sigma_i \rho_i$ = 136.6 $. The correction for the mismatch between the absorption cross section of fuel and poison was made by using a 3-group diffusion equation. The group constant and the fuel cross section were obtained by codes MUFT and TEMPEST. The reactivity change due to the absorption cross section mismatch was obtained by the perturbation calculation. The result was reactivity change due to absorption cross-section mismatch = 0.0622. From this value and from the result of measurements, the value of the effective delayed neutron fraction is given by $\beta_{eff} = (1 + 0.0622/136.6 - 1.2) = 0.00784$. (Nucl. Sci. Abstracts of Japan, 3: No. 2 (Apr. 1964))

**23113** NORTHERN UNIVERSITIES RESEARCH REACTOR. I. Munro and K. G. Stephens (Pye Labs., Ltd., Cambridge, Eng.). Nucl. Eng., 9: 163-5(May 1964).

A description is given of the Manchester/Liverpool Universities research reactor at Risley, Lancs. The reactor is of the Argonaut type, and is a water moderated and cooled graphite system using 90% enriched uranium fuel plates. The control, safety, shielding, fuel loading, and experimental facilities are discussed. (R.E.U.)

**23114** TRANSMISSION AND SCATTERING EXPERIMENTS WITH SLOW NEUTRONS IN THE FRM REACTOR. T. Springer (Kernforschungsanlage, Jülich, Ger.). Nukleonik, 6: 87-94(Mar. 1964). (In German)

A summarizing review is given on the reaction cross section and scattering experiments with slow neutrons, which were carried out in the last year on the FRM Reactor in Munich or which are in progress. Also treated are measurements for determination of pure nuclear data and investigations of their relation to problems of solid-body physics. Most of the experiments described were carried out in work on dissertations. (tr-auth)

**23115** PRR-1 TURNS CRITICAL. Librado D. Ibe (Philippine Atomic Research Center, Manila). Sci. Rev. (Manila), 4: 10-16(Sept. 1963).

The design, pre-criticality tests, approach to criticality, post criticality tests, and planned utilization of the Philippine Research Reactor are discussed. (C.E.S.)

# WASTE DISPOSAL AND PROCESSING

*Refer also to abstracts 22290 and 23139.*

**23116** THE USE OF COMMERCIAL INCINERATORS FOR THE VOLUME REDUCTION OF RADIOACTIVELY CONTAMINATED COMBUSTIBLE WASTES. H. Glauberman and P. Loysen (Atomic Energy Commission, New York). Health Phys., 10: 237-41(Apr. 1964).

AEC contractors were surveyed to determine the extent to which commercial incinerators are used in reducing the volume of contaminated combustible wastes. The incinerators in use are performing successfully both operationally and economically. Along with descriptions of the installation, data are presented for several installations showing initial costs, air dust measurements, volume reduction, and rentention of radioactivity in the ash. The main conclusion is that commercial incinerators are practical for the treatment of combustible wastes generated by fabricators of normal and enriched uranium fuel elements. Units are being operated with high reduction of waste volume, high retention of radioactivity in the ash and with the creation of no appreciable off-site air contamination problems. (auth)

**23117** DERIVATION OF WORKING LIMITS FOR CONTINUOUS RELEASE RATES OF IODINE-131 TO ATMOSPHERE IN A MILK PRODUCING AREA. Pamela M. Bryant (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Health Phys., 10: 249-57(Apr. 1964).

An assessment of derived working limits for continuous iodine-131 release rates is based on a provisional working limit for the concentration in milk of 0.4 $\mu$C/l. The value was derived by the Medical Research Council on the basis that the radiation dose to the thyroid of an infant during its first year should not exceed 3 rems. The meteorological and agricultural conditions assumed are applicable as an annual average to England and Wales. A derived working limit of 20 mC/day of iodine-131 is suggested as the basis of a design figure for an installation, assumed to be the only source of iodine-131 in the area, having a stack of 20 m height at a distance of 500 m from the nearest pasture. The results for other heights and distances are shown graphically. Discharges should be made as uniformly as practicable, and if it is operationally necessary to exceed the continuous release rate over short periods, the quantity released over a few hr should not exceed that permitted for 1 week unless meteorological or agricultural conditions are particularly favorable at the time. Due allowance should be made for multiple releases, and final proof of satisfactory control of the releases always rests on the measurement of the iodine-131 content of milk. (auth)

**23118** SEPARATION OF $^{137}$Cs FROM FUEL REPROCESSING WASTE WITH FERROCYANIDE EXCHANGER. Noriyuki Mishio (Ebara Mfg. Co., Ltd., Japan). Nippon Genshiryoku Gakkaishi, 6: 2-7(Jan. 1964). (In Japanese)

The highly radioactive waste that arises from the processing of irradiated fuel is too hot to handle and hence, in current practice, is stored without treatment in underground tanks for hundreds of years. For removing $^{137}$Cs from the liquid waste, a special solid ion-exchange material, a ferrocyanide-bentonite mixture made by a freezing-thawing method, was developed. This new absorption material has shown its capability of adsorbing Cs exclusively even from 6N nitric acid solution containing various other ions, and $^{137}$Cs has been successfully separated from synthetic Purex waste and Zirflex waste with the new material. Elution of 80% of the $^{137}$Cs from this ferrocyanide-bentonite exchanger was accomplished by use of silver nitrate solutions. (Nucl. Sci. Abstr. of Japan, 3: No. 2 (Apr. 1964))

**23119** FLUIDIZED BED CALCINATION OF HIGH-LEVEL RADIOACTIVE WASTE IN A PLANT-SCALE FACILITY. J. A. Buckham, A. L. Ayers, and J. A. McBride (Phillips Petroleum Co., Idaho Falls, Idaho). New York, American Institute of Chemical Engineers, 1964, Preprint 21d, 20p, $0.50. (CONF-488-7)

From American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964.

Operation of the world's first plant-scale facility for converting high-level radioactive waste solutions to a safer solid form began in December 1963, employing the fluidized bed calcination process. Correlated data from initial operation are presented, with emphasis on the highly satisfactory performance of the off-gas cleanup system. (auth)

**23120** METHOD AND DEVICE FOR THE DISPOSAL OF WATERY RADIOACTIVE WASTE. Rudolf Alberti. German Patent 1,166,392. Mar. 26, 1964. Filed Apr. 2, 1960.

In the method described, a compact solid product is produced from the waste solution. The method comprises the steps of pouring the watery radioactive waste into a container filled with alumina cement, of allowing the saturated mixture to set, and of impregnating the compact block with a liquid synthetic plastic material which plasticizes afterwards. The device described features a container filled with cement into which a system of practically vertical tubes is inserted. The liquid waste is poured into these tubes from above, and as these tubes are provided with perforations the waste leaks into the cement. An essential feature of the invention is that a cement with polydispersed grain size distribution can be used. (Gmelin Inst.)

# GENERAL AND MISCELLANEOUS

**23121** (BNL-805) MERISTEMS AND DIFFERENTIATION. Report of Symposium held June 3-5, 1963. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 253p.

Brookhaven Symposia in Biology No. 16.

Fourteen papers were presented, and separate abstracts were prepared for each. (H.M.G.)

*For abstracts of individual papers see: 21806, 23122, 23123, 23124, 23125, 23126, 23127, 23128, 23129, 23130, 23131, 23132, 23133, and 23134.*

**23122** (BNL-805(p.1-12)) THE PERMANENCE OF MERISTEMS: DEVELOPMENTAL ORGANIZERS OR REACTORS TO EXOGENOUS STIMULI? I. M. Sussex (Yale Univ., New Haven).

The apical meristem of the shoot and of the leaf differ markedly in the degree to which they are dependent on other parts of the plant. The shoot apex has a very stable radial symmetry which is not easily disturbed by experimental procedures, and the meristem returns to radial symmetry after disturbance. The leaf apex is initially radial, but subsequently becomes bilateral through the one-sided influence of the shoot apex. The leaf meristem symmetry can easily be disturbed by experiments carried out early in its development, but once bilateral growth is established the leaf is self determining for continued growth. In the shoot apex the axial distal cells appear to be the ultimate source of new cells, and the marginal region is the site of production of growth centers. The growth centers are produced by the apical meristem, but their position may be modified by existing leaf positions and their development by photoperiod and other exogenous stimuli. The duration of apical growth of the leaf appears to be more easily modified than that of the shoot. The two meristems differ in that the shoot apical meristem is largely self regulating, while that of the leaf passes through a series of critical stages when its development can be extensively modified. (auth)

**23123** (BNL-805(p.13-45)) STUDIES OF THE SURFACE GROWTH OF THE SHOOT APEX OF LUPINUS ALBUS. Kengo Soma and Ernest Ball (North Carolina State Coll., Raleigh).

The question is raised as to the existence of initial cells in the shoot apex. In order to obtain evidence upon either the stability of cell position or possible movements of cells, it is necessary to employ methods of marking them. It was decided to mark the centermost cells of the dome of meristem by two methods. The first method was to kill the marked cell by pushing a very fine glass needle into it. Since the growth of the dicotyledonous shoot apex is known to be a multicellular operation, it was assumed that the loss of one or even of a few of its cells would not significantly change its mode of growth. Data are presented which support this assumption. The second method, which was preliminarily considered, and later proved, to be non-injurious to the cells, consisted in the application of a suspension of carbon black in Dow-Corning Silicone stopcock grease. Both these methods involve in vivo observations and represent moves away from the traditional method of observing a killed specimen. Although the present methods usually marked only the surface cells of the shoot apex, and subsequent observations followed only these outermost cells, it is highly probable that these meristematic cells maintained a constant spatial relationship to each other. It is assumed that cells of the first tunica layer do not move significantly with respect to those of the second tunica layer, or to the underlying corpus. Thus, whether stability of position or movement of the $T_1$ is observed, it can be assumed that there is little gliding of cells over each other. The positional relations of the surface of the shoot apex are considered to indicate those of the underlying tissues as well. (auth)

**23124** (BNL-805(p.59-72)) REGULATED SYNTHESIS OF RNA AND PROTEIN IN THE CONTROL OF CELL DIVISION. Herbert Stern and Yasuo Hotta (Illinois, Univ., Urbana).

The hypothesis that the catalytic apparatus of a cell is laid down during the general period following division, and that the observed orderliness of events need not involve the immediacy of the genome was considered. The enzyme thymidine kinase was used to study this particular point in higher plants. From work with germinating wheat embryos, it was concluded that one of the responses to initiating germination is a selective synthesis of certain proteins. From this conclusion the question arose as to whether cells of the embryo have the capacity to synthesize thymidine kinase and other enzymes at a stage in their life cycle when no obvious external inducement is present. Microspores of a number of plants were used to study this phenomenon. Two sets of experiments are described pointing to two different mechanisms which a cell may use in shifting its metabolic activities in the course of development: a de novo synthesis of protein involving the immediate participation of the genome; and a removal of specific protein involving probably substrate-enzyme interactions within the extrachromosomal portion of the cell. Data suggest that the mechanism of suppressing enzyme synthesis is in one or more respects distinct from those mechanisms that underlie the formation and removal of enzymes. The supposition that developmental cycles perceived at the microscopic level are composed of microcycles perceived at the molecular level in thymidine kinase was investigated in Trillium anthers. Further information concerning the characteristics of periodic activity was obtained by analysis of the RNA formed during active intervals. Isolated microsporocytes of lilies were incubated in the presence of labeled uridine for different intervals of time and the RNA distribution determined. Using methods developed by Nygaard and Hall for measuring hybrid formation between RNA and DNA, hybrid formation was found to occur, and it was specific for lily DNA. (H.M.G.)

**23125** (BNL-805(p.73-88)) GROWTH AND ORGANIZATION IN FREE CELL CULTURES. F. C. Steward (Cornell Univ., Ithaca, N. Y.).

Zygote-like behavior of mature cells isolated from the plant body was studied in the carrot Haplopappus gracilis. Salient features of cell growth and morphogenesis summarized or discussed are: the stimuli to cell growth and cell division; modes of cell division and cell multiplication in isolated or free cells; organization or growth from cells to plants; and embryonic development from somatic cells. Free cultures were initiated and established by rapidly rotating small explants of tissue in flasks or tubes of media competent in growth factors. Cells attached to colonies grow much more readily than single cells or sparsely distributed colonies. It is suggested that parts

of a colony which are not themselves able to grow contribute nutrients to other parts. Work with free cells from carrots led to the conclusion that to release the totipotency of any diploid cell it is necessary to obtain it, like the zygote, as a free cell and to cause it to divide under the influence of the special nutrients drawn from the environment of natural, immature zygotic embryos. It was further found that free cells derived from young embryos are virtually all totipotent and that zygosity in somatic cells is far easier to attain than separation of the zygote from the embryo sac. Whether a cell is zygotic or not is more a function of where it is than what it is. (H.M.G.)

**23126** (BNL-805(p.89-108)) METABOLIC EVENTS DURING THE FORMATION OF A PHOTOSYNTHETIC FROM A NONPHOTOSYNTHETIC CELL. Robert M. Smillie, W. R. Evans, and Harvard Lyman (Brookhaven National Lab., Upton, N. Y.).

It was possible to distinguish and to separate experimentally several metabolic phases associated with the formation of chloroplasts in Euglena. These are outlined. The first recognizable process is that of de-adapting from an environment conducive to heterotrophic growth. This would normally occur when heterotrophic cells move from the logarithmic to the stationary phase of growth. However, the results indicate that, if rapidly growing heterotrophic cells are transferred to conditions favoring only autotrophic growth, the cells must go through a similar process before chloroplast development can proceed at a rapid rate. If cells are exposed to light while still supplied with suitable organic growth substrates, their growth and metabolism remain essentially heterotrophic. Chloroplasts are formed, but these are considerably smaller than the chloroplasts of autotrophic cells. During the de-adaptation process there is a reduction of RNA and protein. If the de-adapted cells are illuminated, a net synthesis of both soluble and ribosomal RNA takes place during the first 12 to 24 hr. This RNA appears to function in the synthesis of chloroplast protein. If the production of the ribosomal RNA is prevented by 5-fluorouracil, there is a reduction in the subsequent synthesis of chloroplast protein. After the first 12 to 24 hr of illumination the synthesis of chloroplast protein is unaffected by 5-fluorouracil although it can still be inhibited by chloramphenicol. During the period of net RNA synthesis there is a synthesis of nonplastid proteins. These include enzymes of the hexose monophosphate shunt, mitochondrial enzymes, and ribonuclease. The synthesis of these proteins is unaffected by concentrations of 5-fluorouracil and chloramphenicol which inhibit the synthesis of chloroplast protein. The primary function of these proteins appears to be in the breakdown of existing reserves to produce substrate carbon, adenosine triphosphate, and reduced nicotine adenine dinucleotides for the synthesis of the proteins and lipids of the chloroplast. The bulk of the chloroplast protein is formed between 12 and 72 hr after the cells are placed in the light. During this period there is a decrease in nonplastid protein. This protein probably constitutes a major source of amino acids for the synthesis of the chloroplast protein. As the chloroplasts develop they can, through photosynthesis, provide an increasingly greater share of the energy required for synthetic processes. Eventually, as the chloroplasts mature, the substrate carbon required for respiration and cellular syntheses during cell division and growth is supplied entirely by photosynthesis. (auth)

**23127** (BNL-805(p.109-25)) SEX EXPRESSION IN FLOWERING PLANTS. J. Heslop-Harrison (Birmingham. Univ., England).

Work is reviewed on various hermaphrodite, dioecious, and monoecious plants. Hypotheses are advanced about the kinds of control mechanisms that might operate in the differentiating floral meristem. Examples quoted reveal the different kinds of diciiny that are characterized by the ways in which they exhibit the breakdown of physiological control over sex differentiation. Cytogenetical evidence does not suggest the developmental stage at which the chromosomal mechanism might function. It is conceivable that determination in the floral meristems might result from pervasive influences established by the allosome complement early in the life of the zygote, or alternatively that the differential parts of the allosomes are quiescent during vegetative growth and are activated only during flower differentiation. To decide between the possibilities, a strictly dioecious race of Melandrium rubrum is compared with a hermaphroditic species of the neighboring genus Silene for response to various environmental and growth substance treatments. In S. pendula it was found that the effects of abnormal photoperiodic regimes in inducing male sterility are closely simulated with auxins. Melandrium behaved as though the sex-determining processes were local ones not affected by profound disturbances of the auxin balance of the plant as a whole or by severe modification of such other parts of general metabolism as may be modified by photoperiod. Responses in Melandrium parallel those of Silene to the extent that male fertility and ovary growth can be affected by applied auxins. Features of sex expression in maize were determined from an analysis of the responses of an inbred sugar-corn cultivar to environmental and growth substrate treatments. Models for sex control mechanisms are presented. (H.M.G.)

**23128** (BNL-805(p.126-37)) DEVELOPMENTAL STUDIES OF VEGETATIVE AND FLORAL MERISTEMS. Ernest M. Gifford, Jr. (California. Univ., Davis).

Transition to flowering is described for species of three genera, certainly quite remote phylogenetically from each other. They are Chenopodium album (lamb's-quarters), Pharbitis nil (strain, "Violet"), and Xanthium pennsylvanicum (cocklebur). There seems to be little doubt that there is something different about the histone picture in apices of Xanthium three days after the inductive night as well as in Chenopodium album after four inductive cycles. Perhaps in describing cytoplasmic staining by Fast Green one is justified in speaking only of basic proteins until the substance (or substances) is identified with certainty. Much evidence indicates that the DNA/nucleohistone ratio remains relatively constant in the vegetative tissue of a given species. There are reports, however, that the amounts of nuclear histone may vary in proliferating tissue. (auth)

**23129** (BNL-805(p.138-56)) DEVELOPMENTAL STUDIES OF FLOWERING. Richard A. Popham (Ohio State Univ., Columbus).

Seven types of shoot apex organization in plants are illustrated, and applications for plant genetics and physiology are pointed out. Events in the flowering sequence of Chrysanthemum morifolium var. Bittersweet are outlined and illustrated. Places of origin of floral parts are identified for several species. (H.M.G.)

**23130** (BNL-805(p.157-69)) PROTEIN SYNTHESIS DURING CELL GROWTH AND DIFFERENTIATION. R. Brown (Edinburgh Univ.).

A preliminary treatment of certain general aspects of cellular differentiation is included, since it is this process which here provides the context for protein synthesis. The significance of protein synthesis for differentiation is considered after certain general aspects of cellular differentia-

tion are described. The process of cellular differentiation is considered as it occurs in the meristematic regions and particularly at the apex of the root. In this situation the cells, immediately after they are formed in an ill-defined terminal region, are all more or less similar, and they all have the same configuration. They are all relatively small, they are isodiametric, they have thin walls, and they are nonvacuolated. About half of those formed persist in the meristematic state and do not develop further. Half, on the other hand, become committed to the process of expansion. In this typically the cell enlarges considerably, a large central vacuole develops which displaces the protoplast to a peripheral position, and always the shape changes. Clearly expansion is itself a form of differentiation. At the same time the final form and activity of the cell are not constant. The cells expand into a variety of forms. Most assume the parenchymatous configuration, but many acquire other more prominent patterns. Superimposed on the general process of expansion, a secondary transformation must also be distinguished which secures variety in a population of cells. In a sense expansion, while being itself a differentiation, is also a vehicle for further differentiation. Thus two aspects of cellular differentiation are distinguished: the general process of expansion and the diversification that occurs within it. (auth)

**23131** (BNL-805(p.170-8)) THE MOLECULAR BASIS OF DIFFERENTIATION. Geoffrey Zubay (Brookhaven National Lab., Upton, N. Y.).

The underlying theoretical framework of both regulation and differentiation is discussed. Metabolic control is interpreted in view of the Jacob and Monod gene operator and regulator model. Levels at which the repressor operates (gene or messenger RNA) are considered, and it is concluded that at present regulation at the DNA level seems highly likely. Control at the RNA level is possible but not nearly so important due to the limited lifetime of messenger RNA. The regulator-operator model requires RNA synthesis to begin only at the operator locus. This mechanism of regulation is illustrated. Behavior of DNA and RNA polymerase is compared, and it is suggested that the RNA polymerase is much more sensitive to things bound to the DNA surface than is the DNA polymerase. The relation of DNA and histones is reviewed. (H.M.G.)

**23132** (BNL-805(p.179-202)) CELL DEVELOPMENT DURING PLANT EMBRYOGENESIS. William A. Jensen (California. Univ., Berkeley).

Basic problems, along with the available data on cell development in early embryogenesis, are reviewed in relation to the cotton embryo. The mature megagametophyte is used as the starting point because the structural organization of the egg has an important role in the development of the zygote, which in turn determines the direction of development of the young embryo. Structure and composition of the mature megagametophyte, the zygote, and the embryo are discussed. (H.M.G.)

**23133** (BNL-805(p.203-17)) CELL WALLS AND THE GEOMETRY OF PLANT GROWTH. Paul B. Green (Pennsylvania. Univ., Philadelphia).

Hydrodictyon and Nitella axillaris were used to study the role of the wall texture in cell form in respect to cylindrical cell with diffuse growth, change from the cylindrical form to the spherical form, and cell proportions. Diffuse growth at constant diameter, tip-growing cells, and the cytoplasmic framework in Nitella were also considered. (H.M.G.)

**23134** (BNL-805(p.218-34)) THE POLARITY OF AUXIN TRANSPORT. A. C. Leopold (Purdue Univ., Lafayette, Ind.).

The polar transport of auxin is an active transport process, as implied by the characteristics of its specificity, concentration relations, and sensitivity to inhibitors. Furthermore, it seems to be a secretion activity, thus finding its structural basis somewhere within the structural features of the individual cell. The extent of transport polarity varies over a very wide range, from the essentially completely polar coleoptiles and young stems to the weakly polar petioles and roots. Examination of the relative polarity of auxin transport between tissues and between plant parts at various stages of development or following tropistic stimulation suggests that the variations may involve differences in the directional feature of active secretion. In cases in which auxin participates in the differentiation of tissues, the transport system appears to provide a basic element of axis polarity in growth and differentiation of plants. (auth)

**23135** (BNL-7471) AUTORADIOGRAPHIC STUDY ON THE ORIGIN AND FATE OF SMALL LYMPHOID CELLS IN THE DOG BONE MARROW: EFFECT OF FEMORAL ARTERY CLAMPING DURING IN VIVO AVAILABILITY OF THYMIDINE-$H^3$. G. Keiser, H. Cottier, N. Odartchenko, and V. P. Bond (Brookhaven National Lab., Upton, N. Y.). [Oct. 11, 1963]. Contract AT(30-2)-Gen-16. 26p. (CONF-500-1)

From Conference on Radiation Protection and Recovery, Oak Ridge, Tenn., Nov. 1963.

The origin and fate of small lymphoid cells in the dog bone marrow were studied autoradiographically by observing the effect of clamping of the femoral artery during in vivo availability of tritiated thymidine. Heavily labeled small lymphoid cells appeared in the bone marrow of the clamped leg 3 hr after injection of thymidine-$H_3$, thus indicating their hematogenous origin. Thereafter the labeling index of small lymphoid cells in the marrow of the clamped leg rose to more than 20% on day 6 after injection of tritiated thymidine, but did not reach the values observed in the control marrow. There was no evidence for a transformation of migrated small lymphoid cells into erythroblasts during the first 48 hr after injection of tritiated thymidine. (auth)

**23136** (CONF-481-49) PROPAGATION OF ULTRASOUND IN CAMPHENE. Carl E. Scheie and John R. Green (New Mexico. Univ., Albuquerque). [1961]. Contract AT(11-1)-733. 11p.

From American Physical Society Annual Meeting, New York, Jan. 1964.

Ultrasound measurements were made on crystals of dl-camphene. A very strong interconversion of the transverse and longitudinal modes of sound transmission at interfaces was observed, and transit times were measured. The mean velocities of longitudinal and transverse waves at room temperature were determined to be 1470 and 725 m/sec, respectively (ratio $v_L/v_T = 2.03$). The velocity equation was solved, and the results, when compared with the experimental ratio $v_L/v_T$, indicate the elastic constants to be $c_{11} = 1.21 \times 10^{10}$ dynes/cm$^2$ and $c_{44} = 0.93 \times 10^{10}$ dynes/cm$^2$. (D.L.C.)

**23137** (DPST-64-83-3) USAEC-AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, MARCH 1964. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Apr. 17, 1964. Contract AT(07-2)-1. 15p.

The effects of spacing on the heat transfer characteristics of rod bundles are being studied. The electrical arc damage to the Star Test Section was repaired. Two damaged heaters in the surrounding-rod mock-up were also replaced, and the central-rod mock-up was rebuilt. Tests

were begun to determine the gas and liquid handling ability of sieve trays with downpipes in heavy water production plants. Results indicated that no increase in capacity resulted from the change from segmental downcomers to downpipes. Orientation of zirconium hydride platelets in thin-walled Zircaloy tubing is being studied. The preferred orientations of 6 different types of tubing varied widely. The orientation of (0002) poles ranged from predominantly circumferential to predominantly radial with very few oriented in the longitudinal direction. (M.C.G.)

**23138** (HW-68600-37) PLUTONIUM ABSTRACTS. Volume 4, Number 3. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1, 1964. Contract AT(45-1)-1350. 22p.

Thirty abstracts of papers on plutonium technology are presented. Subject fields covered include: biology and medicine, chemistry, health and safety, metallurgy and ceramics, physics, and reactor technology. (M.C.G.)

**23139** (NP-13876) RAPPORT SUR L'EXERCICE, 1962. (Report on Work, 1962). (Centre d'Energie Nucleaire, Brussels). 71p.

The activities of the center are summarized. Reactor operation and research, dosimetry, reactor materials, fuel element development and processing, industrial research and development, solid state physics, nuclear physics, transuranium elements, radiobiology, safety operations, waste treatment, and mathematical services are covered. (D.C.W.)

**23140** (RFP-367) ELECTROLESS NICKEL PLATING ON ALUMINUM. W. H. Roberts (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Jan. 10, 1964. Contract AT(29-1)-1106. 10p.

Three principal steps, each closely controlled, were found to ensure a sound, adherent electroless nickel coating over aluminum: the chemical deposition of an intermediate zinc film, which is very thin and continuous, from a "dilute" zincate solution; autocatalytic nickel deposition to the desired thickness from a slow-bright-alkaline electroless nickel solution; and short-term heat treatment, preferably in vacuo unless coated finally with an electrodeposit of gold. The actual plating of electroless nickel was the most difficult to duplicate qualitatively. A partially automated plating unit, comprised of rather sophisticated equipment, is considered desirable for regulating the strict limits of pH, temperature, and composition specified to promote a uniformly bright and adherent nickel deposit. (auth)

**23141** (SC-DC-64-433) MEMORY SYSTEMS STUDY. Final Report. G. R. Peterson, R. C. DeVries, and J. L. Melsa (Arizona. Univ., Tucson. Engineering Research Lab.). Dec. 31, 1963. For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 95p.

Results of theoretical studies of learning control systems are presented. The need for definitions is discussed; and definitions of successful, adaptive, and learning control systems are presented. The basic structural elements of learning control systems are discussed, and the environmental characteristics of control situations in which learning may be applicable are considered. Learning control systems are classified in accordance with the environmental situation in which they might operate. The structure and components suitable to various environmental situations are discussed, and findings related to the application of the Sandia analog core to analog computer systems are also presented. (auth)

**23142** (SC-TM-329-63(74)) THE MEASUREMENT OF THICKNESS AND RATE OF DEPOSITION OF THIN FILMS USING QUARTZ CRYSTALS. K. W. Limestahl (Sandia Lab., Albuquerque, N. Mex.). Dec. 1963. Contract [AT (29-1)-789]. 16p.

A method for monitoring the thickness and rate of deposition of thin films during the deposition process is discussed. It is shown that a quartz crystal oscillator provides a simple and accurate means of accomplishing this measurement. (auth)

**23143** (TID-3722) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE ISSUED OR IN PROGRESS DURING THE PERIOD, FEBRUARY–MARCH 1964. (Division of Technical Information Extension, AEC). 24p.

A listing of bibliographies issued and in preparation during February and March 1964 in the field of atomic energy is presented. One hundred and eighteen references are included. (M.C.G.)

**23144** (TID-20506) GEOLOGIC ASPECTS OF THORIUM RECOVERY FROM COMMON ROCKS. Quarterly Progress Report, December 1, 1963–February 29, 1964. (Rice Univ., Houston, Tex.). For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract 1491. 44p.

A fully automated system for gamma-spectrometric determination of thorium, uranium, and potassium in solid rock cores was put into operation. The spectrometric data are read out on punched paper tape and the spectrometric calculations done on a computer. Data for coring site A on the Kancamagus Highway are presented. Average values were obtained by gamma spectrometry for the thorium and uranium contents of some orthoquartzites and graywackes. The Atoka and Jackfork quartz sandstones of Western Arkansas averaged approximately 4 ppm thorium and 1 ppm uranium. The Umpqua and Tyee graywackes of Western Oregon averaged approximately 7 ppm thorium and 2 ppm uranium. Weighted average concentrations for all sandstones were 5.5 ppm thorium and 1.7 ppm uranium. Much of the radioactivity, particularly in the graywackes, was carried by heavy minerals such as biotite and zircon. The average concentrations in sand-sized materials were, therefore, lower and may be estimated as 3 ppm thorium and 1 ppm uranium. An unidentified alpha activity at about 4.4 Mev was observed in thorium samples and it is suggested that the parent isotope causing this activity may be $^{244}Pu$. (M.C.G.)

**23145** (TID-20535) TAUT-LINE NAVIGATION BUOYS USED IN THE THRESHER SEARCH. Technical Report No. CU-9-64. Robert Gerard (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Apr. 1964. Contract AT(30-1)-2663. 13p.

Six navigation buoys were placed by the R/V CONRAD of Lamont Geological Observatory in May and June, 1963 in the THRESHER search area. All buoys used taut-line moorings set in a depth of about 1375 fathoms, using regular lay nylon rope of $^{9}/_{16}$-inch diameter. Anchors, consisting of five one-foot cubes of cast iron shackled together in two groups, were used in most cases. By experiment, the best results were obtained where the mooring line was cut to a length, measured under low tension, of 15 percent less than the bottom depth. The maximum circle of movement for the buoys had a radius of about 200 yards. (auth)

**23146** (UCRL-7555) IBM-1401 COMPUTER PRODUCED AND MAINTAINED PRINTED BOOK CATALOGS AT THE LAWRENCE RADIATION LABORATORY. James H. Kennedy and Merle N. Boylan (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 21, 1964. Contract W-7405-eng-48. 26p.

A computer program is described for the production and maintenance of printed book catalogs. The catalog is main-

tained or updated using an IBM-1401 computer, sorted or alphabetized using an IBM-7094 computer, and printed using the printer attached to the IBM-1401 computer. The card catalog is divided into three sections: author-title; subject; and shelf list. Some of the basic steps that should be followed for a printed book catalog are listed. A general description of the book catalog and its unique features is included. (P.C.H.)

**23147** (UCRL-7556) IBM-1401 COMPUTER PRODUCED AND MAINTAINED KEYWORD-PLUS-TITLE (KWPT) INDEX FOR REPORTS, PHOTOGRAPHS, AND SPECIFICATIONS. James H. Kennedy (California. Univ. Livermore. Lawrence Radiation Lab.). Jan. 27, 1964. Contract W-7405-eng-48. 10p.

In order to provide a better indexing product than the previous Keyword-In-Context indexes, a new set of computer programs were written for the IBM-1401 computer in order to generate a list of citations and a Keyword-Plus-Title (KWPT) index. The new computer programs use the same punched card input used for generating printed book and report catalogs and 3 × 5 inch catalog cards. Applications of the KWPT index are given. (P.C.H.)

**23148** (AEC-tr-6389) A STUDY OF CAUSTIC EMBRITTLEMENT OF BOILERPLATES. G. T. Athavale and W. Eilender. Translated by L. P. Costas (Savannah River Lab., Aiken, S. C.), from Korrosion u Metallschutz, 16: 127-32(1940). 3p.

Experiments showed that no significant relationship exists between caustic embrittlement and aging, Ehn grain size or nitrogen content. Nitriding was beneficial to highly susceptible steels. A medium cooling rate from the normalizing temperature or quenching with subsequent annealing at 650°C increased stability. Cold working was undesirable. Stability of annealed steels was enhanced by aluminum. Alumina appears detrimental. (auth)

**23149** (ANL-Trans-8) SALINE COMPOUNDS AND INTERMETALLIC PHASES OF SODIUM IN LIQUID AMMONIA (1st REPORT ON METALS AND ALLOYS). E. Zintl, J. Goubeau, and W. Dullenkopf. Translated by Lydia Venters (Argonne National Lab., Ill.), from Z. Physik. Chem. (Leipzig) A, 154: 1-46(1931). 43p.

Metallic sodium in liquid ammonia was reacted with other elements. A transition series from sodium halides to intermetallic phase of sodium was obtained. The sodium was not reacted directly with the free element but with a compound of the element. The compounds formed were usually readily soluble in ammonia and their color was extremely intense. The saline nature of the compounds with elements in Groups I to IV in the ammonia solution was proved. Elements in Groups V to VII did not form saline compounds with sodium in ammonia; but they produced insoluble ammonia-free alloy phases with atomic lattices. (M.C.G.)

**23150** (ANL-Trans-10) ON THE CLASSIFICATION AND IDENTIFICATION OF 3nj-COEFFICIENTS. SOME 21j-, 24j- AND 27j-COEFFICIENTS. S. Budryte and A. Jucys. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Lietuvos Fiz. Rinkinys, Nos. 3-4, 271-81(1961). 10p.

A new method of classification of 3nj-coefficients based on the number of polygon conditions is proposed. This method of classification is much more simple and takes into account the properties of corresponding 3nj-coefficients. On the basis of these properties a method of identification of 3nj-coefficients is proposed. Symmetry properties and standard diagrams of some of 21j-, 24j- and 27j-coefficients are given. (auth)

**23151** (ANL-Trans-11) A FURTHER INVESTIGATION OF POLYGONAL CONDITIONS. J. Ciplys, S. Budryte, and A. Jucys. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Lietuvos Fiz. Rinkinys, 1: Nos. 3-4, 263-[illegible] (1961). 8p.

The structures of the polygons in the polygon conditions in 18j-coefficients are given. The triangle and polygon conditions of matrix elements of the operators and of the transformation matrices between the functions of different coupling schemes are treated. (auth)

**23152** (LA-tr-64-3) TRANSITION OF NORMAL BURNING OF POROUS EXPLOSIVES TO DETONATION UNDER CONDITIONS OF SLOWLY INCREASING PRESSURE. V. K. Bobolev, L. F. Chekirda, and S. V. Chuko. Translated by L. C. Smith and Helen J. Chick (Los Alamos Scientific Lab., N. Mex.), from Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 4, 99-101(1963). 9p.

It was established that, in the burning of fusible porous explosives under increasing pressure, the molten layer closes the pores completely only at low pressures. With an increase of pressure the integrity of the layer is disrupted, the pores are opened, and an infiltration of gases develops. Also, the critical pressure for disrupting the integrity of the molten layer $P_*$ is small. The experimental results were obtained mainly on hexogen with particle dimensions of 160-250 $\mu$, with a relative density of $\delta = 0.7$, and with ignition by means of a spiral of wire at an initial pressure of one atmosphere. (P.C.H.)

**23153** (ORNL-tr-71) HIGHER STATES OF EXCITATION OF COLOR CENTERS. Fritz Luety. Translated for Oak Ridge National Lab., Tenn., from Z. Physik, 160: 1-15(1960). 21p.

In additively colored KCl, KBr, KI, RbCl, RbBr, and RbI, the absorption on the short-wave side of the F-band was investigated. Besides the K band, three new absorption peaks $L_1$, $L_2$, and $L_3$ were found, all in a fixed relation to the F-band. The experimental data indicate that K, $L_1$, $L_2$, and $L_3$ are transitions of the F-electron to higher excited states, the three highest of which are conductive states. By comparing the absorption band areas, the relative transition probabilities to the different excited states were obtained. (auth)

**23154** (ORNL-tr-81) THE STATE OF STRESS IN A THICK-WALLED CYLINDRICAL HIGH-PRESSURE CONTAINER MADE OF PRESTRESSED CONCRETE. Radim Servit. Translated for Oak Ridge National Lab., Tenn., from Jaderna Energie 4: 19-26(1958). 28p.

A thick-walled cylindrical high pressure container of large dimensions exposed to substantial internal pressure and to nonuniform heating of its walls may be designed of prestressed concrete. One possible means to attain the necessary prestressing is the use of a system of transverse and longitudinal cables, which are tightened after the concrete sets. Stress equations applicable to the concrete body were derived for the various phases in the process of construction and use of the container. A practical example was computed on the basis of equations to prove the feasibility of such design. It is shown at the same time that the number of cables required for prestressing is affected most substantially by non-uniform heating of the walls. Any arrangement that lowers the temperature gradient in the walls will therefore have a favorable effect. The results can serve as a basis for more precise calculations and for improvements in the design of such containers. (auth)

**23155** (SC-T-64-611) THIN-LAYER CHROMATOGRAPHY. IV. SCHEME, BORDER EFFECT, ACIDIC AND

BASIC LAYERS, STEP TECHNIQUE. Egon Stahl. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Arch. Pharm., 292: 411-16(1959). 9p.

Thin-layer chromatography, an adsorption-chromatographic micromethod, is carried out with very thin silica-gel-G layers, which are spread on glass plates. Additional possibilities and working techniques are described. Border phenomena were removed by oversaturation of the chamber. The effects of acidic and basic silica-gel-G layers were determined. A step technique was developed. (M.C.G.)

**23156** (SC-T-64-612) INVESTIGATIONS WITH THE AID OF THIN-LAYER ELECTROPHORESIS. G. Pastuska and H. Trinks. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Chemiker Ztg., 86: 135-8(1962). 11p.

Methodic investigations in the domain of thin-layer electrophoresis are described. Phenols permitted investigation of the $M_G$ values as a function of the test duration as well as of the humidity (moisture) content. The influence of the pH value of the electrolyte on electrophoresis was also studied. The ability of the carrier layer to absorb substances and the influence of added amounts of acid on the $M_G$ values are reported. Special separation methods for the thin-layer electrophoresis of naphthalenes, amines, amino acids, and dyes are described. (auth)

**23157** (SC-T-64-614) THIN-LAYER CHROMATOGRAPHY. Egon Stahl. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Z. Anal. Chem., 181: 303-12(1961). 15p.

Methods and uses of thin-layer chromatography are discussed. Preparation of thin sorption layers, spreading-on on substances to be separated, selection of elution agents, visualization, and techniques are described. The lower determination limit, scope of application, and new possibilities of utilization are discussed. (M.C.G.)

**23158** (SC-T-64-619) PHOTOGRAPHIC FACTOR IN ELECTROMICROGRAPH. Yasuo Shimizu. Translated by Shyoko Hiraga (Sandia Corp., Albuquerque, N. Mex.) from J. Electromicroscopy (Tokyo), 11: 199-206(1962). 20p.

Sensitivity and graininess of dry plates used in electron microscopes, resolving limit of dry plates of electron microscopes and permissible scope of multiplying factor, and image reproduction of the electron micrograph are discussed. (P.C.H.)

**23159** VOM RADIOTHOR ZUR URANSPALTUNG. EINE WISSENSCHAFTLICHE SELBSTBIOGRAPHIE. (From Radiothorium to Uranium Fission. A Scientific Autobiography). Otto Hahn. Burgplatz, Ger., Friedr. Vieweg and Sohn, 1962. 207p.

The work of Otto Hahn on radiothorium, thorium C, radioactinium, mesothorium, radium, $\beta$ particles, radioactive rubidium and potassium, protactinium, uranium, gamma radiation, radiochemistry, uranium fission, the transuranium series, fission products, neptunium, and radiometric absorption analysis is reviewed. Reprints of three original papers are included: (1) Detection of Formation of Active Barium Isotopes from Uranium and Thorium by Neutron Irradiation, Detection of Further Active Fragments in Uranium Fission; (2) On the Experimental Unraveling of Elements and Kinds of Atoms Appearing in the Fission of Uranium; and (3) The Chemical Separation of the Elements and Kinds of Atoms Originating in the Fission of Uranium. (M.C.G.)

**23160** THE SOCIAL ASPECTS OF NUCLEAR ANXIETY. Stewart Meacham. Am. J. Psychiat., 120: 837-41 (Mar. 1964).

The psychologic aspects of threat of nuclear war and pacifist views opposing development and production of thermonuclear weapons are presented. (BBB)

# CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

| | | |
|---|---|---|
| æ | becomes | ae |
| ö | | oe |
| ø | | oe |
| ü | | ue (except in transliterated Chinese names) |

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# SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

## General Indexing Style

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair. However, the information would not be indexed under the experimental animal, e.g., Rats, unless the report discusses the effects on rat hair as compared with the effect on the hair of other animals.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

## Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

## Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

## Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

## Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
  Al–Cr ...
CHROMIUM ALLOYS
  Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly with cross references under the element components. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
  Si–W ...
TUNGSTEN SYSTEMS
  Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

## Physical States of Materials

In this subject index specification of the physical state of the material, if other than normal, is included in the modifying phrase.

## Modifying Phrases (Subheadings)

Descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract than would be possible with only a word or two whenever it appears that such information would be useful. Such phrases are written so that the idea considered most important is presented first, should a not-too-awkward expression result. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

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| HMSO | Her Majesty's Stationery Office, London. |
| IAEA | Available from the International Atomic Energy Agency. |
| JCL | For sale by the Special Libraries Association Translation Center, John Crerar Library, 35 West 33rd Street, Chicago, Illinois 60616. |
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| NAS | National Academy of Sciences, National Research Council, Washington, D. C. 20418. |
| NRC | For sale by the National Research Council of Canada, Ottawa, Ontario, Canada. |
| ORINS | Available on interlibary loan from the Library, Oak Ridge Institute of Nuclear Studies, Post Office Box 117, Oak Ridge, Tennessee 37831. |
| OTS | For sale by the Office of Technical Services, Department of Commerce, Washington, D. C. 20230. |
| UKAEA, London | Available from United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S. W. 1. |
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| Report No. | Abstract No. | Availability |
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| **A-AC–** | (Misc.) | |
| 82/G/L.922 | 18-22256 | Papers Meteorol. Geophys. (Tokyo), 14: 58-65(1963) |
| **AD–** | (Misc.) | |
| 272637 | 18-22825 | |
| 414164 | 18-22548 | $8.10(OTS) |
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| 417241 | 18-22668 | $3.60(OTS) |
| 417338 | 18-22948 | See PIBMRI-1056-62 |
| 417451 | 18-22805 | See AFCRL-63-305 |
| 417472 | 18-22424 | See WAL-TR-401/303-2 |
| 417493 | 18-22697 | See AFOSR-5282 |
| 417502 | 18-22268 | $15.00(OTS) |
| 417675 | 18-22444 | See NSAR-63-126 |
| 417692 | 18-22411 | $7.60(OTS) |
| 418564 | 18-22937 | See GNE/PHYS/63-13 |
| 418986 | 18-22414 | See ASD-TR-7-756(X) |
| 419395 | 18-22949 | See RADC-TDR-63-240 |
| 419396 | 18-22807 | See RM-3744-PR |
| 419495 | 18-22554 | See PA-TR-3090 |
| 419518 | 18-22269 | $11.00(OTS) |
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| 422106 | 18-22412 | |
| 423413 | 18-22472 | |
| 426848 | 18-22413 | $1.60(OTS) |
| 426950 | 18-22237 | |
| 432824 | 18-22934 | See ARL-64-24 |
| 433886 | 18-21828 | See USNRDL-TR-713 |
| 434600 | 18-22533 | See REIC-ACCESS-73 |
| 434785 | 18-22261 | $3.60(OTS) |
| 435879 | 18-22928 | $8.10(OTS) |
| 436023 | 18-22452 | $3.60(OTS) |
| 436274 | 18-22549 | $8.60(OTS) |
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| 6393 | 18-22224 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
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| 1890 | 18-21803 | Dep.; $1.00(AECL) |
| 1890(p.30-8) | 18-21851 | Can. J. Plant Sci., 41: 805-13(1961) |
| 1890(p.39-41) | 18-21848 | Can. Food Ind., (August 1963) |
| 1890(p.62-4) | 18-21849 | Can. J. Animal Sci., 42: 215-17(1962) |
| 1890(p.65-81) | 18-21852 | Can. J. Zool., 40: 401-20(1962) |
| 1895 | 18-22523 | See CRFD-1179 |
| 1900 | 18-22272 | See CRRD-1137 |
| **AEEW-R–** | (British) | |
| 205 | 18-22197 | Dep.(mc) |
| 227 | 18-22545 | Dep.(mc) |
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| 4517 | 18-21999 | Dep.; $1.60(BIS); 8s. (HMSO) |
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| 4590 | 18-22708 | Dep.; $0.50(BIS); 2s. 6d. (HMSO) |
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| 901 | 18-22208 | Dep.; $1.60(fs), $0.80(mf) JCL |
| **AFCRC-TR–** | (Misc.) | |
| 56-267 | 18-22648 | |
| **AFCRL–** | (Non-AEC) | |
| 62-895 | 18-22948 | See PIBMRI-1056-62 |
| 63-305 | 18-22805 | $5.60(OTS) |
| 63-907 | 18-22929 | |
| **AFOSR–** | (Misc.) | |
| 5282 | 18-22697 | $1.60(OTS) |
| 64-0803 | 18-22930 | |
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| 8090 | 18-22473 | Dep.(mc); $8.10(fs), $2.78(mf) OTS |
| **Al-Trans–** | | |
| 43 | 18-22555 | Dep.(mc); $4.60(fs), $1.52(mf) JCL |
| **ANL–** | | |
| 6649 | 18-22453 | Dep.; $1.75(OTS) |
| 6809 | 18-23009 | Dep.; $2.25(OTS) |
| 6814 | 18-22864 | Dep.; $2.00(OTS) |
| 6815 | 18-22164 | Dep.; $1.00(OTS) |
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| 8 | 18-23149 | Dep.(mc); $4.60(fs), $1.49(mf) JCL |
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| 64-14 | 18-22931 | |
| 64-15 | 18-22932 | |
| 64-17 | 18-22933 | |
| 64-24 | 18-22934 | $1.60(OTS) |
| 64-44(Pt.I) | 18-22935 | |
| 64-45 | 18-22936 | |
| **AROD–** | (Misc.) | |
| 3006:6 | 18-22000 | |
| 3331:5 | 18-22669 | |
| **ASD-TR–** | (Non-AEC) | |
| 7-756(X) | 18-22414 | $5.60(OTS) |
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| 142 | 18-22474 | Dep.(mc); $2.60(fs), $1.01(mf) OTS |
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| 4673-T7 | 18-22475 | |
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| 1218 | 18-22454 | Dep.(mc); $5.60(fs), $1.76(mf) OTS |
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| 10081 | 18-22477 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 10082 | 18-22415 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
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| 805 | 18-23121 | Dep.; $2.50(OTS) |
| 838 | 18-22988 | Dep.; $0.50(OTS) |
| 7005 | 18-22997 | p.345-65 of "Materials and Fuels for High-Temperature Nuclear Energy Applications," Cambridge, Mass., The M.I.T. Press, 1964 |
| 7471 | 18-23135 | Dep.(mc); $2.60(fs), $0.98(mf) OTS; Gmelin, AED-CONF-63-263-1 |
| 7615 | 18-22045 | J. Chem. Phys., 40: 2670-9(1964) |
| 7640 | 18-22638 | Rev. Sci. Instr., 35: 624-5(1964) |
| 7710 | 18-22515 | Phys. Rev., 134: A1329-36(1964) |
| 7784 | 18-22001 | Dep.(mc); $3.60(fs), $1.16(mf) OTS; Gmelin, AED-CONF-63-061-35 |
| 7940 | 18-21763 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
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| 1089 | 18-22369 | EM |
| 1104 | 18-22325 | EM |
| CEA-Bib– | (French) | |
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| CEA-tr– | (French) | |
| R-1727 | 18-22120 | Dep.(nc); $1.60(fs), $0.80(mf) JCL |
| CERN– | (European Organization for Nuclear Research) | |
| 64-16 | 18-22312 | Dep.(nc) |
| 64-18 | 18-22407 | Dep.(nc) |
| 64-19 | 18-22586 | Dep.(nc) |
| CLOR– | (Polish) | |
| 19 | 18-22270 | Dep. |
| CLOR-IBJ– | (Polish) | |
| II-22 | 18-22331 | Dep. |
| CONF-45– | (American Ceramic Society Basic Science Division Meeting, Washington, D. C., Oct. 1963) | |
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| CONF-73– | (6th Biennial Conference on Carbon, Pittsburgh, June 1963) | |
| 23 | 18-22001 | See BNL-7784 |
| 24 | 18-22086 | ORINS. Gmelin, AED-CONF-63-061-34 |
| CONF-74– | (11th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963) | |
| 26 | 18-22210 | ORINS. Gmelin, AED-CONF-63-050-22 |
| CONF-110– | (American Institute of Chemical Engineers 56th Annual Meeting, 1963 Annual Meeting, Houston, Tex., Dec. 1963) | |
| 5 | 18-22311 | ORINS. Gmelin, AED-CONF-63-249-8 |
| CONF-117– | (American Chemical Society 145th National Meeting, New York, Sept. 1963) | |
| 42 | 18-21955 | Dep.(nc); $2.60(fs), $1.01(mf) OTS; Gmelin, AED-CONF-63-133-51 Anal. Chem., 36: 1320-4(1964) |
| 43 | 18-22520 | ORINS. Gmelin, AED-CONF-63-133-53 |
| CONF-158– | (American Society of Agricultural Engineers, 1963 Annual Meeting, Miami Beach, Fla., June 1963) | |
| 2 | 18-21911 | ORINS. Gmelin, AEC-CONF-63-099-2 |
| CONF-173– | (American Meteorological Society 44th Annual Meeting, Los Angeles, Calif., Jan. 1964) | |
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| CONF-174– | (12th Annual Conference Application of X-ray Analysis, Denver, Aug. 1963) | |
| 11 | 18-22162 | ORINS. Gmelin, AED-CONF-63-123-1 |
| 12 | 18-22521 | ORINS. Gmelin, AED-CONF-63-123-8 |
| CONF-179– | (American Chemical Society Radioactidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964) | |
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| 13 | 18-22326 | ORINS. Gmelin, AED-CONF-64-008-6 |
| CONF-187– | 18-381 | (American Nuclear Society Meeting, New York, Nov. 1963) |
| 73 | 18-22526 | See HW-SA-3128 |
| 124 | 18-22468 | ORINS. Gmelin, AED-CONF-63-225-89 |
| 126 | 18-22987 | ORINS. Gmelin, AED-CONF-63-225-96 |
| CONF-206– | (Symposium on Carbides in Nuclear Energy, Harwell, Eng., Nov. 1963) | |
| 6 | 18-22484 | See HW-SA-3131 |
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| 26 | 18-22002 | Dep.(nc); $1.60(fs), $0.80(mf) OTS |
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| 9 | 18-22309 | ORINS. Gmelin, AED-CONF-63-257-10 |
| 10 | 18-22310 | ORINS. Gmelin, AED-CONF-63-257-10 |
| CONF-281– | (International Conference on Beryllium Oxides, Sydney, Oct. 1963) | |
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| 47 | 18-22495 | See UCRL-7022(Rev.1) |
| 48 | 18-22479 | Dep.(nc); $2.60(fs), $1.07(mf) OTS |
| 49 | 18-22531 | See ORNL-TM-742 |
| CONF-296– | (Symposium on Unimolecular Reactions in the Mass Spectrometer and Related Topics in Chemical Kinetics, Salt Lake City, July 1963) | |
| 5 | 18-22107 | ORINS. Gmelin, AED-CONF-63-144-9 |
| CONF-303– | (3rd International Conference on the Mössbauer Effect, Ithaca, New York, Sept. 1963) | |
| 17 | 18-22087 | ORINS. Gmelin, AED-CONF-63-143-15 |
| CONF-322– | (American Chemical Society Production Technology of Np-237 and Pu-238, Denver, Jan. 1964) | |
| 8 | 18-22109 | $2.60(fs), $0.92(mf) OTS; Gmelin, AED-CONF-64-002-4; Z. Naturforsch., 19a: 6-12(1962) |
| 11 | 18-22166 | Dep.(nc); $3.60(fs), $1.16(mf) OTS; Gmelin, AED-CONF-64-002-14 |
| CONF-364– | (16th Annual Gaseous Electronics Conference, Pittsburgh, Oct. 1963) | |
| 8 | 18-22211 | ORINS. Gmelin, AED-CONF-63-195-10 |
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| 1 | 18-21763 | See BNL-7940 |
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| 53 | 18-22782 | ORINS. Gmelin, AED-CONF-64-003-60 |
| 55 | 18-22927 | ORINS. Gmelin, AED-CONF-64-003-62 |
| **CONF-488–** | **(American Institute of Chemical Engineers 53rd National Meeting, Pittsburgh, May 1964)** | |
| 1 | 18-22189 | New York, American Institute of Chemical Engineers, 1964, Preprint 21a, $0.50. ORINS |
| 2 | 18-22191 | New York, American Institute of Chemical Engineers, 1964, Preprint 15a, $0.50. ORINS |
| 3 | 18-22190 | New York, American Institute of Chemical Engineers, 1964, Preprint 15b, $0.50. ORINS |
| 4 | 18-22186 | New York, American Institute of Chemical Engineers, 1964, Preprint 15c, $0.50. ORINS |
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| 6 | 18-22188 | New York, American Institute of Chemical Engineers, 1964, Preprint 21c, $0.50. ORINS |
| 7 | 18-23119 | New York, American Institute of Chemical Engineers, 1964, Preprint 21d, $0.50. ORINS |
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| 2 | 18-22317 | See UCRL-7730 |
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| **CONF-500–** | **(Conference on Radiation Protection and Recovery, Oak Ridge, Tenn., Nov. 1963)** | |
| 1 | 18-23135 | See BNL-7471 |
| 2 | 18-21760 | ORINS. Gmelin, AED-CONF-63-263-2 |
| **CONF-502–** | **(International Congress of Nuclear Physics, Paris, July 1964)** | |
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| 2 | 18-23052 | Dep.(nc); $2.60(fs), $0.83(mf) OTS |
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| 1137 | 18-22272 | Dep.; $1.00(AECL) |
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| 227 | 18-22726 | See NEVIS-121 |
| **CURL–** | **(Non-AEC)** | |
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| 59-12-210 | 18-22480 | Dep.(nc); $2.60(fs), $1.01(mf) OTS |
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| **DLCS–** | | |
| 5000264 | 18-23053 | Dep.(nc); $5.60(fs), $1.79(mf) OTS |
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| **EOS–** | **(Non-AEC)** | |
| 3130-Annual | 18-22548 | See AD-414164 |
| **EURAEC–** | | |
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| 1029 | 18-22005 | See DRI-2156 |
| 1030 | 18-22474 | See ATL-A-142 |
| 1031 | 18-22477 | See BMI-X-10081 |
| 1032 | 18-22415 | See BMI-X-10082 |
| 1035 | 18-22221 | See GEAP-4608 |
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| B1978 | 18-22984 | See NYO-10721 |
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| **FZK–** | **(Non-AEC)** | |
| 159-1 | 18-22525 | |
| **GA–** | **(Misc.)** | |
| 4551 | 18-23041 | p.170-213 of "Materials and Fuels for High-Temperature Nuclear Energy Applications," Cambridge, Mass., The M.I.T. Press, 1964 |

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| 4562 | 18-23040 | p.130-69 of "Materials and Fuels for High-Temperature Nuclear Energy Applications," Cambridge, Mass., The M.I.T. Press, 1964 |
| 4659 | 18-22848 | Dep.; $3.00(OTS) |
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| 77529 | 18-22440 | Dep.; $0.50(OTS) |
| 77581 | 18-21956 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 77831 | 18-22234 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 78953 | 18-23032 | Dep.; $11.00(fs), $4.61(mf) OTS |
| 79048 | 18-22441 | Dep.; $2.60(fs), $0.83(mf) OTS |
| 79921 | 18-23057 | Dep.(mc); $2.60(fs), $0.92(mf) OTS |
| 80020 | 18-22550 | Dep.; $1.50(OTS) |
| 80829 | 18-23058 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 81075 | 18-22458 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| HW-SA– | | |
| 2118 | 18-21957 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 3128 | 18-22526 | $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-26 |
| 3131 | 18-22484 | Dep.(mc); $2.60(fs), $1.10(mf) OTS |
| 3171 | 18-23039 | Nukleonik, 6: 94-102(1964) |
| 3453 | 18-23084 | Dep.(mc); $5.60(fs), $1.97(mf) OTS |
| 3460 | 18-22006 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| I– | (Misc.) | |
| B2106-1 | 18-22413 | See AD-426848 |
| IDO– | | |
| 14628 | 18-22169 | Dep.; $0.50(OTS) |
| 16958 | 18-23097 | Dep.; $1.50(OTS) |
| 16965 | 18-22313 | Dep.; $0.50(OTS) |
| IITRI– | (Misc.) | |
| B6021-1 | 18-22418 | |
| T6042-4 | 18-23001 | Dep.(mc); $2.60(fs), $0.86(mf) OTS |
| IPPJ– | (Japanese) | |
| 22 | 18-22938 | Dep.(mc) |
| 24 | 18-22939 | Dep.(mc) |
| IS– | | |
| 650 | 18-22508 | J. Less-Common Metals, 6: 313-21(1964) |
| 690 | 18-22509 | J. Less-Common Metals, 6: 322-5(1964) |
| 707 | 18-22504 | J. Appl. Phys., 35: 1752-3(1964) |
| 738 | 18-22222 | Dep.; $2.50(OTS) |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 767 | 18-22101 | Inorg. Chem., 3: 690-2(1964) |
| ISS– | (Italian) | |
| 63/9 | 18-22[illegible] | p.(mc) |
| 63/47 | 18-22719 | Dep.(mc) |
| 64/1 | 18-22720 | Dep.(mc) |
| JINR– | (Russian) | |
| E-1591 | 18-22721 | Dep.(mc) |
| P-1586 | 18-22722 | Dep.(mc) |
| P-1590 | 18-22587 | Dep.(mc) |
| P-1592 | 18-22723 | Dep.(mc) |
| P-1596 | 18-22724 | Dep.(mc) |
| P-1597 | 18-22725 | Dep.(mc) |
| JPL-TR– | (Non-AEC) | |
| 32-553 | 18-22940 | |
| JPRS– | (Non-AEC) | |
| 22336 | 18-22462 | $1.00(OTS) |
| 24227 | 18-21780 | $0.75(OTS) |
| 24281 | 18-22248 | $0.50(OTS) |
| 24289(Del.) | 18-22121 | $2.50(OTS) |
| 24301(Del.) | 18-21830 | $1.50(OTS) |
| 24435 | 18-22649 | $6.00(OTS) |
| K-L– | | |
| 6002 | 18-22190 | See CONF-488-3 |
| 6003 | 18-22189 | See CONF-488-1 |
| KAPL-M– | | |
| 6102 | 18-22442 | Dep.(mc); $3.60(fs), $1.22(mf) OTS |
| 6116 | 18-22408 | Dep.(mc); $8.60(fs), $3.20(mf) OTS |
| KN– | (Non-AEC) | |
| 63-685-11 | 18-23098 | |
| KY– | | |
| 452 | 18-22007 | Dep.; $1.00(OTS) |
| 456 | 18-21958 | Dep.; $0.75(OTS) |
| LA– | | |
| 2996 | 18-22851 | Dep.; $1.25(OTS) |
| 3001 | 18-22336 | Dep.; $2.25(OTS) |
| 3007 | 18-22551 | Dep.; $0.75(OTS) |
| 3040 | 18-22170 | Dep.; $0.75(OTS) |
| 3043 | 18-22409 | Dep.; $1.50(OTS) |
| LA-tr– | | |
| 64-3 | 18-23152 | Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS |
| LADC– | | |
| 5962 | 18-22556 | Am. J. Phys., 32: 347-54(1964) |
| 6116 | 18-22228 | J. Appl. Phys., 35: 1990-1(1964) |
| 6122 | 18-22033 | Inorg. Chem., 3: 727-9(1964) |
| LAL– | (French) | |
| 1090 | 18-22552 | Dep.(mc) |
| LAMS– | | |
| 3041 | 18-22709 | Dep.; $1.00(OTS) |
| 3056 | 18-22670 | Dep.; $3.00(OTS) |
| 3059 | 18-22806 | Dep.; $0.50(OTS) |
| 3063 | 18-22443 | Dep.; $1.00(OTS) |
| MAB– | (Non-AEC) | |
| 196-M | 18-22235 | |
| MATT– | | |
| 195 | 18-22941 | Dep.; $2.75(OTS) |
| 229 | 18-22323 | Rev. Sci. Instr., 35: 640-1(1964) |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 242 | 18-22942 | Dep.; $2.25(OTS) |
| 243 | 18-22943 | Dep.; $0.75(OTS) |
| 256 | 18-22944 | Dep.(mc); $2.60(fs), $0.86(mf) OTS |
| **MCW–** | | |
| 1454 | 18-22171 | Dep.; $0.50(OTS) |
| 1483 | 18-22485 | Dep.; $0.50(OTS) |
| **MSAR–** | **(Misc.)** | |
| 63-126 | 18-22444 | $1.60(OTS) |
| 64-45 | 18-22445 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **N–** | **(Misc.)** | |
| 63-22918 | 18-22707 | See AD-420962 |
| 64-11758 | 18-22472 | See AD-423413 |
| 64-12377 | 18-22412 | See AD-422106 |
| 64-13186 | 18-22274 | $1.60(fs), $0.80(mf) OTS |
| **NAA-SR–** | | |
| 6387 | 18-23059 | Dep.; $1.25(OTS) |
| 7020 | 18-23013 | Dep.; $0.50(OTS) |
| 7465 | 18-22486 | Dep.; $1.50(OTS) |
| 8262 | 18-22487 | Dep.; $0.75(OTS) |
| 8381 | 18-22488 | Dep.; $1.00(OTS) |
| 9233 | 18-22852 | Dep.; $1.25(OTS) |
| **NASA-CR–** | **(Non-AEC)** | |
| 40 | 18-22527 | $2.00(OTS) |
| 54018 | 18-22475 | See BATT-4673-T7 |
| **NASA-TN–** | **(Misc.)** | |
| D-2279 | 18-22553 | Dep.; $0.50(OTS) |
| **NDL-TM–** | **(Non-AEC)** | |
| 14 | 18-22337 | |
| **NEVIS–** | **(Misc.)** | |
| 121 | 18-22726 | |
| **NLCO–** | | |
| 903 | 18-22489 | Dep.; $1.50(OTS) |
| **NP–** | **(AEC File No. for Non-AEC Reports)** | |
| 13797 | 18-22783 | |
| 13798 | 18-22945 | |
| 13816 | 18-22459 | |
| 13838 | 18-22873 | Dep.(mc) |
| 13860 | 18-22727 | Dep.(mc) |
| 13870 | 18-22728 | |
| 13871 | 18-22729 | Dep.(mc) |
| 13876 | 18-23139 | Dep.(mc) |
| 13877 | 18-22730 | |
| 13879 | 18-22784 | Dep.(mc) |
| 13880 | 18-22731 | |
| 13881 | 18-22710 | |
| 13882 | 18-22785 | |
| 13885 | 18-22275 | |
| 13888 | 18-22008 | |
| 13889 | 18-22009 | |
| 13890 | 18-22732 | |
| 13893 | 18-22786 | |
| 13896 | 18-22733 | |
| **NP-tr–** | **(AEC File No. for Non-AEC Translations)** | |
| 1130 | 18-22023 | Dep.(mc); $2.60(fs), $0.95(mf) JCL |
| 1135 | 18-21929 | $2.60(fs), $0.92(mf) JCL |
| 1136 | 18-22281 | Dep.(mc); $1.10(fs), $0.80(mf) JCL |
| 1138 | 18-22128 | Dep.(mc); $1.10(fs), $0.80(mf) JCL |
| **NRS–** | **(Australian)** | |
| 11 | 18-22110 | Dep.(mc) |

| Report No. | Abstract No. | Availability |
|---|---|---|
| **NYO–** | | |
| 162-5 | 18-22338 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **NYO–** | | |
| 2310-1 | 18-22117 | See RRL-133 |
| 2945-1 | 18-23035 | Dep.; $0.50(OTS) |
| 10220 | 18-22379 | Dep.; $1.75(OTS) |
| 10600 | 18-23060 | Dep.(mc); $12.50(fs), $5.54(mf) OTS |
| 10721 | 18-22984 | Dep.; $2.50(OTS) |
| **ORNL–** | | |
| 3591 | 18-21947 | Dep.; $3.50(OTS) |
| 3599 | 18-22020 | Dep.; $0.50(OTS) |
| **ORNL-TM–** | | |
| 630 | 18-22278 | Dep.(mc); $2.60(fs), $1.04(mf) OTS |
| 705 | 18-22034 | Inorg. Chem., 3: 730-4(1964) |
| 742 | 18-22531 | Dep.(mc); $2.60(fs), $0.89(mf) OTS |
| 818 | 18-22492 | Dep.(mc); $3.60(fs), $1.22(mf) OTS |
| 838 | 18-23014 | Dep.(mc); $3.60(fs), $1.40(mf) OTS |
| 847 | 18-23062 | Dep.(mc); $4.60(fs), $1.58(mf) OTS |
| 849 | 18-22532 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **ORNL-tr–** | | |
| 71 | 18-23153 | Dep.(mc); $2.60(fs), $0.83(mf) JCL |
| 81 | 18-23154 | Dep.(mc); $2.60(fs), $1.04(mf) JCL |
| 90 | 18-22227 | Dep.(mc); $4.60(fs), $1.49(mf) JCL |
| **ORO–** | | |
| 615 | 18-21807 | Dep.; $1.25(OTS) |
| **OTS–** | **(Misc.)** | |
| 63-11453/2 | 18-21750 | $1.25(OTS) |
| 64-21047 | 18-22462 | See JPRS-22336 |
| 64-31088 | 18-21780 | See JPRS-24227 |
| 64-31117 | 18-22248 | See JPRS-24281 |
| 64-31121(Del.) | 18-22121 | See JPRS-24289(Del.) |
| 64-31131(Del.) | 18-21830 | See JPRS-24301(Del.) |
| 64-31190 | 18-22649 | See JPRS-24435 |
| **PA-TR–** | **(Non-AEC)** | |
| 3090 | 18-22554 | $7.60(OTS) |
| **PAN–** | **(Polish)** | |
| 440/IX | 18-22339 | Dep. |
| 455/IA | 18-22340 | Dep. |
| 464/XVII | 18-22114 | Dep. |
| 472/XVIII | 18-22947 | Dep. |
| 476/II | 18-22874 | Dep. |
| 477/IA | 18-22592 | Dep.(mc) |
| 484/II | 18-22341 | Dep. |
| 489/XVII | 18-22115 | Dep. |
| 490/XVII | 18-22116 | Dep. |
| **PATENTS** | **(British)** | **3s. 6d. each, U. K. Patent Office** |
| 954,014 | 18-22212 | |
| 955,755 | 18-23043 | |
| 957,141 | 18-22213 | |
| 957,186 | 18-22327 | |
| 957,293 | 18-23078 | |
| 957,295 | 18-22192 | |
| 957,956 | 18-23079 | |
| **PATENTS** | **(French)** | |
| 1,335,830 | 18-22403 | |
| **PATENTS** | **(German)** | |
| 1,158,191 | 18-23080 | |
| 1,158,641 | 18-23044 | |
| 1,159,919 | 18-22193 | |
| 1,160,005 | 18-22370 | |

| Report No. | Abstract No. | Availability |
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| 1,160,116 | 18-22371 | |
| 1,160,120 | 18-22647 | |
| 1,160,190 | 18-22469 | |
| 1,160,191 | 18-22089 | |
| 1,160,193 | 18-22433 | |
| 1,160,247 | 18-22214 | |
| 1,160,559 | 18-23006 | |
| 1,160,560 | 18-23045 | |
| 1,160,633 | 18-22470 | |
| 1,160,636 | 18-22434 | |
| 1,160,644 | 18-22471 | |
| 1,160,646 | 18-22435 | |
| 1,160,647 | 18-22436 | |
| 1,160,957 | 18-22372 | |
| 1,160,958 | 18-23046 | |
| 1,161,360 | 18-23000 | |
| 1,161,730 | 18-22215 | |
| 1,162,529 | 18-22216 | |
| 1,162,575 | 18-22090 | |
| 1,162,821 | 18-22194 | |
| 1,165,778 | 18-22217 | |
| 1,166,392 | 18-23120 | |
| **PATENTS** | **(Japanese)** | |
| 19,101 | 18-22404 | |
| 19,102 | 18-22405 | |
| 19,252 | 18-22406 | |
| **PATENTS** | **(U. S.)** | |
| 3,128,233 | 18-23081 | |
| 3,128,235 | 18-23047 | |
| 3,128,247 | 18-22091 | |
| 3,128,378 | 18-22328 | |
| 3,128,380 | 18-22373 | |
| 3,128,381 | 18-22196 | |
| 3,128,385 | 18-22236 | |
| 3,128,887 | 18-22218 | |
| 3,129,055 | 18-22437 | |
| 3,129,056 | 18-22092 | |
| 3,129,140 | 18-23048 | |
| 3,129,141 | 18-23049 | |
| 3,129,142 | 18-23050 | |
| 3,129,331 | 18-22264 | |
| 3,129,333 | 18-22374 | |
| 3,129,334 | 18-22375 | |
| 3,129,353 | 18-22329 | |
| 3,130,841 | 18-23007 | |
| 3,132,076 | 18-23033 | |
| 3,132,996 | 18-22982 | |
| 3,132,997 | 18-23051 | |
| 3,133,248 | 18-22330 | |
| 3,133,485 | 18-22219 | |
| 3,133,867 | 18-23008 | |
| 3,134,019 | 18-22376 | |
| **PATENTS** | **(U.S.S.R.)** | |
| 150,625 | 18-22163 | |
| 158,119 | 18-22377 | |
| 159,238 | 18-22378 | |
| 159,811 | 18-22195 | |
| **PB-** | **(Non-AEC)** | |
| 171809-6 | 18-22493 | |
| **PIBMRI-** | **(Non-AEC)** | |
| 1056-62 | 18-22948 | $1.60(OTS) |
| **R-** | **(Misc.)** | |
| 197 | 18-22549 | See AD-436274 |
| 419 | 18-22726 | See NEVIS-121 |
| 2270 | 18-22347 | For translation see EURAEC-1008 |

| Report No. | Abstract No. | Availability |
|---|---|---|
| **RADC-TDR-** | **(Misc.)** | |
| 63-240 | 18-22949 | $6.60(OTS) |
| **REIC-Access-** | **(Non-AEC)** | |
| 73 | 18-22533 | $3.60(OTS) |
| **RFP-** | | |
| 210 | 18-21959 | Dep.(mc); $2.60(fs), $1.10(mf) OTS |
| 366 | 18-22460 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| 367 | 18-23140 | Dep.(mc); $1.10(fs), $0.80(mf) OTS |
| **RHD-** | **(Non-AEC)** | |
| Vol.V, No.4 | 18-22257 | $0.50(GPO) |
| **RISO-** | **(Danish)** | |
| 70 | 18-22342 | Dep.(mc) |
| 74 | 18-22950 | Dep.(mc) |
| **RM-** | **(Misc.)** | |
| 3744-PR | 18-22807 | $2.60(OTS) |
| 3755-PR | 18-22951 | |
| **RRL-** | | |
| 133 | 18-22117 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **RSA-** | **(Swedish)** | |
| 39 | 18-22343 | Dep.(mc) |
| **RT-BIO-** | **(Italian)** | |
| (63)-8 | 18-21761 | Dep.(mc) |
| **RTD-TDR-** | **(Non-AEC)** | |
| 63-4132 | 18-22711 | |
| **S-** | **(Misc.)** | |
| 235-R | 18-22275 | See NP-13885 |
| **SB-** | **(Non-AEC)** | |
| 63-61 | 18-22452 | See AD-436023 |
| 401(Suppl.1) | 18-22447 | $0.10(OTS) |
| **SC-DC-** | | |
| 64-433 | 18-23141 | Dep.(mc); $8.60(fs), $3.05(mf) OTS |
| 3443 | 18-22505 | J. Appl. Phys., 35: 1767-70(1964) |
| **SC-DR-** | | |
| 285-63 | 18-23085 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **SC-R-** | | |
| 64-124 | 18-22534 | Dep.; $0.75(OTS) |
| **SC-T-** | | |
| 64-611 | 18-23155 | Dep.(mc); $1.10(fs), $0.80(mf) JCL |
| 64-612 | 18-23156 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| 64-614 | 18-23157 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| 64-619 | 18-23158 | Dep.(mc); $1.60(fs), $0.80(mf) JCL |
| **SC-TM-** | | |
| 64-69 | 18-22535 | Dep.(mc); $7.60(fs), $2.54(mf) OTS |
| 64-534 | 18-21960 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 329-63(74) | 18-23142 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **SGAE-BL-** | **(Austrian)** | |
| 3/1964 | 18-21742 | Dep.(mc) |
| 4/1964 | 18-21764 | Dep.(mc) |
| **SGAE-CH-** | **(Austrian)** | |
| 2/1964 | 18-23100 | Dep.(mc) |
| 3/1964 | 18-23101 | Dep.(mc) |
| **SGAE-RE-** | **(Austrian)** | |

| Report No. | Abstract No. | Availability |
|---|---|---|
| 1/1964 | 18-22223 | Dep.(mc) |
| **SLAC–** | | |
| 26 | 18-22315 | Dep.; $0.50(OTS) |
| 27 | 18-22593 | Dep.; $2.00(OTS) |
| **TEI–** | | |
| 841 | 18-22260 | Dep.(mc); $11.00(fs), $4.58(mf) OTS |
| **TID–** | | |
| 3722 | 18-23143 | Dep.; Free(DTIExtension) |
| 7662 | 18-22989 | Dep.; $4.25(OTS) |
| 7684 | 18-21808 | Dep.; $2.75(OTS) |
| 7691 | 18-22594 | Dep.(mc); $23.50(fs), $14.90(mf) OTS |
| 18865 | 18-21948 | Dep.; $0.50(OTS) |
| 19020 | 18-21789 | Crop Sci., 3: 386-9(1963) |
| 19118 | 18-21836 | Am. J. Physiol., 206: 289-93(1964) |
| 19666 | 18-22636 | Rev. Sci. Instr., 35: 549-57(1964) |
| 19959(Rev.) | 18-22494 | Dep.(mc); $4.60(fs), $1.64(mf) OTS |
| 20019 | 18-23066 | Dep.(mc); $10.10(fs), $3.95(mf) OTS |
| 20084 | 18-22321 | Rev. Sci. Instr., 35: 587-91(1964) |
| 20098 | 18-22576 | Rev. Sci. Instr., 35: 634-6(1964) |
| 20110 | 18-22186 | See CONF-488-4 |
| 20254 | 18-22514 | Phys. Letters, 9: 89-90(1964) |
| 20386 | 18-22743 | Phys. Letters, 9: 191-4(1964) |
| 20506 | 18-23144 | Dep.(mc); $4.60(fs), $1.52(mf) OTS |
| 20515 | 18-22787 | Dep.(mc); $6.60(fs), $2.12(mf) OTS |
| 20529 | 18-22758 | Phys. Rev. Letters, 12: 522-3(1964) |
| 20535 | 18-23145 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 20537 | 18-22316 | Dep.(mc); $2.60(fs), $1.01(mf) OTS |
| 20541 | 18-22118 | Dep.(mc); $3.60(fs), $1.13(mf) OTS |
| 20584 | 18-22202 | Dep.(mc); $3.60(fs), $1.16(mf) OTS |
| 20585 | 18-22203 | Dep.(mc); $4.60(fs), $1.49(mf) OTS |
| 20586 | 18-22204 | Dep.(mc); $5.60(fs), $1.88(mf) OTS |
| 20587 | 18-22205 | Dep.(mc); $5.60(fs), $1.97(mf) OTS |
| 20588 | 18-22206 | Dep.(mc); $6.60(fs), $2.12(mf) OTS |
| 20589 | 18-22419 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| **TM-ST–** | **(Swiss)** | |
| 18 | 18-23068 | For translation see ANL-Trans-13 |
| **TO-B–** | **(Non-AEC)** | |
| 64-31 | 18-22985 | |
| **TRG-Inf. Ser.–** | **(British)** | |
| 382 | 18-22429 | Dep.; $0.90(BIS) 4s. 6d. (HMSO) |
| **UCB–** | **(Non-AEC)** | |
| 64-2 | 18-22736 | |
| **UCRL–** | | |
| 7022(Rev.1) | 18-22495 | Dep.(mc); $3.60(fs), $1.37(mf) OTS |
| 7088(Rev.I) | 18-22671 | Dep.; $3.00(OTS) |
| 7555 | 18-23146 | Dep.; $0.50(OTS) |
| 7556 | 18-23147 | Dep.; $0.50(OTS) |
| 7716 | 18-22246 | Dep.; $0.50(OTS) |
| 7730 | 18-22317 | Dep.(mc); $2.60(fs), $0.98(mf) OTS |
| 7740 | 18-22875 | Dep.(mc); $1.60(fs), $0.80(mf) OTS |
| 10890 | 18-22448 | Dep.; $1.00(OTS) |
| 10962 | 18-22032 | Inorg. Chem., 3: 639-44(1964) |
| 11099 | 18-22675 | J. Chem. Phys., 40: 2504-7(1964) |
| 11103 | 18-22021 | Dep.; $1.00(OTS) |
| 11169 | 18-22876 | Dep.; $2.25(OTS) |
| 11184 | 18-21747 | Dep.; $2.75(OTS) |
| 11184(p.86-90) | 18-22345 | Rev. Sci. Instr., 35: 693-7(1964) |
| 11214 | 18-22461 | Dep.; $0.75(OTS) |
| 11215 | 18-21749 | Dep.; $0.75(OTS) |
| 11229 | 18-22022 | Dep.; $2.00(OTS) |
| 11358 | 18-22760 | Phys. Rev. Letters, 12: 527-30(1964) |
| 13097(Vol.I) | 18-23087 | Dep.(mc); $16.00(fs), $7.55(mf) OTS |
| 13097(Vol.II) | 18-23088 | Dep.(mc); $13.00(fs), $5.63(mf) OTS |
| 13097(Vol.III) | 18-23089 | Dep.(mc); $13.50(fs), $5.99(mf) OTS |
| **UCRL-Trans–** | | |
| 1042(L) | 18-22500 | Dep.(mc); $2.60(fs), $0.86(mf) JCL |
| **UR–** | | |
| 641 | 18-22247 | Dep.; $0.75(OTS) |
| **URS–** | **(Non-AEC)** | |
| 638-2 | 18-22279 | |
| **USBM-U–** | **(Misc.)** | |
| 1109 | 18-22420 | Dep.; $0.75(OTS) |
| **USNRDL-TR–** | **(Non-AEC)** | |
| 713 | 18-21828 | $2.60(OTS) |
| 719 | 18-22346 | |
| **VDDIT–** | **(Swedish)** | |
| 8[illegible] | 18-22175 | Dep.(mc) |
| **WADD-TR–** | **(Non-AEC)** | |
| 60-646(Pt.3, Vol.II) | 18-22497 | |
| **WAL-TR–** | **(Non-AEC)** | |
| 401/303-2 | 18-22424 | $4.60(OTS) |
| **WANL-PR–** | **(Misc.)** | |
| M-005 | 18-22425 | |
| M-006 | 18-22498 | |
| (P)-002 | 18-22426 | |
| (Q)-002 | 18-22427 | |
| **WCAP–** | **(Misc.)** | |
| 6061 | 18-23067 | Dep.; $2.50(OTS) |
| **WP–** | **(Non-AEC)** | |
| 22/8 | 18-21928 | Dep.(mc) |
| **Y–** | | |
| 1460 | 18-22280 | Dep.; $0.50(OTS) |

# Appendix I

# NUCLEAR SCIENCE ABSTRACTS CATEGORY DEFINITIONS

## BIOLOGY AND MEDICINE

### General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

### Ecology

Studies of the movement of radioactive and other materials through organisms and the environment and influence of these materials on natural communities. The measurement and hazards of radioactive materials in the biosphere are included in the subcategory *Radiation Hazards and Protection* of this category.

### Metabolism, Tissue Distribution, and Toxicology

Chemical and metabolic processes in living organisms and the absorption, metabolism, utilization, and toxicological significance of materials ingested, inhaled, or otherwise entering the organisms. Studies performed to establish maximum allowable concentrations of radioactive materials are included in the subcategory *Radiation Hazards and Protection* of this category.

### Radiation Effects

Information on the effects of radiation on organisms or their components, including radiation sickness.

### Radiation Effects Therapy and Countermeasures

Use of biological extracts, chemical compounds, or drugs to alter, prevent, simulate, or treat the effects of radiation on organisms or their components. The use of special shields to prevent radiation effects is included in the subcategory *Radiation Hazards and Protection* of this category.

### Radiation Hazards and Protection

Measurement and hazards of radioactive material in the biosphere; studies of maximum permissible concentrations of radioactive materials on organisms or their components; and the use of rules, procedures, and equipment to reduce radiation exposure. Users of this subcategory should also see the subject category HEALTH AND SAFETY.

### Radiotherapy and Radiodiagnosis

Use of both external and internal radiation sources in the diagnosis and therapy of disease. Also includes all phases of radiation equipment, procedure, and effectiveness. For radiation side effects, see the subcategory *Radiation Effects* of this category.

# CHEMISTRY

This category excludes *biochemistry*, which is found in the category BIOLOGY AND MEDICINE; *corrosion* which is a subcategory of METALS, CERAMICS, AND OTHER MATERIALS; and *geochemistry* which is included in the category GEOLOGY AND MINERALOGY.

## General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

## Analytical Procedures

Qualitative and quantitative procedures, radiochemical analysis, neutron-activation analysis, and mass spectroscopy.

## Inorganic and Physical Chemistry

Chemistry of elements and inorganic compounds and chemical thermodynamics. Chemistry of elements and inorganic compounds also is included in the subcategories *Analytical Procedures, Radiation Chemistry and Radiochemistry,* and *Separation Processes and Procedures* of this category and in the category METALS, CERAMICS, AND OTHER MATERIALS. Radiation effects on chemical properties and reactions are included in the subcategory *Radiation Chemistry and Radiochemistry* of this category.

## Organic Chemistry

Chemical and physical properties and reactions of organic compounds and systems of compounds. Equipment and procedures for investigating such properties and reactions are also included. For radiation effects on organic compounds, see the subcategory *Radiation Chemistry and Radiochemistry* of this category. Also see the subcategory *Separation Processes and Procedures* of this category.

## Radiation Chemistry and Radiochemistry

Radiation effects on chemical properties and reactions, radiation effects on physical properties of nonmetallic elements and compounds and organic compounds, and special chemical procedures and equipment required as a result of the presence of radiation. Also includes the generation of visible light as a result of radiation. Radiation effects on biological materials are included in the subcategory *Radiation Effects* of the category BIOLOGY AND MEDICINE. Radiation effects on metals and intermetallic compounds are included in the category METALS, CERAMICS, AND OTHER MATERIALS. Also see the subcategory *Separation Processes and Procedures* of this category and the category WASTE DISPOSAL AND PROCESSING.

## Separation Processes and Procedures

Chemistry and chemical engineering for processing uranium and thorium ores and reactor fuel and breeder materials. Also includes chemical separations not designed for analytical purposes or for isotopic separations of an element. Analytical separations are included in the subcategory *Analytical Procedures* of this category, and separations of isotopes of an element are included in the category ISOTOPE TECHNOLOGY.

# ENGINEERING

### General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

### Applications of Nuclear Explosions

Engineering applications of nuclear explosions or simulated nuclear explosions.

### Facilities and Equipment

Plants, plant facilities, and equipment not designed for specific application in one of the other categories.

### Heat Transfer and Fluid Flow

Theoretical studies and engineering applications of heat transfer and fluid flow. For thermodynamics and magnetofluiddynamics, see the subcategory *General* of the category PHYSICS.

### Materials Testing

Information primarily concerned with equipment, methods, and techniques for destructive or nondestructive testing. When the material is of primary interest, information on testing (including corrosion and erosion) is included in the category METALS, CERAMICS, AND OTHER MATERIALS.

### Protective Structures

Design, construction, and effectiveness of blast and fallout shelters and other protective structures.

### Vacuum Engineering

Design and construction of vacuum systems and equipment (e.g., vacuum pumps). Excludes properties of materials under vacuum environment and vacuum systems and equipment that are more appropriately categorized according to the application (e.g., a vacuum system specifically intended for an accelerator is included in the subcategory *Accelerators* of the category PHYSICS).

# GEOLOGY AND MINERALOGY

### General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

### Natural Radioactivity and Fallout

Ground levels and movement of radioactive materials, both natural and artificial, and elemental and isotopic compositions of minerals.

### Site Survey and Selection

Reactor and plant site-selection studies.

### Techniques and Equipment

Use of radiometric techniques and equipment in geology, mineralogy, and seismology associated with nuclear-explosion detection.

### Thorium and Uranium Minerals

Structures and properties of thorium and uranium minerals.

# HEALTH AND SAFETY

Critical limits for moving and storing fissionable, radioactive, and toxic materials; experience in applied health physics; the development of, and experience with, personnel-protection procedures; and general industrial- and radiation-hazards analyses. Excludes studies performed to establish maximum allowable concentrations and limits of exposure, which are included in the subcategory *Radiation Hazards and Protection* of the category BIOLOGY AND MEDICINE.

# INSTRUMENTATION

This category excludes the specific applications of an instrument. These are categorized by the subject of the application.

## General

Design, testing, and use of instruments, except radiation detection, where these aspects of instrumentation are the main subjects.

## Radiation Detection

Radiation-detection instruments and their components.

# ISOTOPE TECHNOLOGY

## General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

## Industrial Applications

Applications to industrial processes and equipment for such applications. Applications to basic research are found under such categories as CHEMISTRY.

## Power Application

Applications of radioisotopes in the production of electric or thermal energy or thrust.

## Separation and Production

Separation of isotopes of one element in microquantities or macroquantities. Separation of isotopes of different elements is included in the subcategory *Separation Processes and Procedures* of the category CHEMISTRY.

# MATHEMATICS AND COMPUTERS

Pure mathematics; statistics; and the design, development, and operation of computers. Information on applied mathematics and computer applications is categorized according to the application (e.g., computers used as simulators of various devices and pro-

cesses are categorized in the same manner as the device or process simulated; computer codes and applied mathematics are categorized on the basis of the application).

## METALS, CERAMICS, AND OTHER MATERIALS

The term "other materials" refers to such substances as plastics, rubbers, other elastomers, wood, concrete, graphite, and petroleum.

### General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

### Corrosion

Corrosion and erosion studies that appear to be directed toward specific applications. Excludes studies primarily concerned with physical chemistry, reaction kinetics, etc., which are included in the category CHEMISTRY.

### Fabrication

Fabrication methods, procedures, and equipment, including those for fuel elements and reactor components.

### Properties and Structure

Mechanical, physical, and structural properties.

### Radiation Effects

Effects of radiation on mechanical, physical, and structural properties. Chemical effects of radiation are included in the subcategory *Radiation Chemistry and Radiochemistry* of the category CHEMISTRY.

## METEOROLOGY

Atmospheric and weather conditions, climatology, general meteorological problems, and meteorological studies made for the purpose of obtaining information on the movement of air-borne particulate matter. Meteorology included in site-selection reports is included in the subcategory *Site Survey and Selection* of the category GEOLOGY AND MINERALOGY.

## PHYSICS

### General

Information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

### Accelerators

Theory, design, development, construction, and operation of high-voltage machines and particle accelerators.

### Astrophysics and Cosmology

Origin and cosmic abundance of elements, isotopic composition of meteorites, stellar processes, and stellar magnetic fields.

### Atomic Physics

Physical properties and theory of atoms and their interactions, reactions, and scattering. Also includes the production of atomic beams and the effects and mechanisms of atomic beam bombardment of materials.

### Cosmic Radiation

Origin, intensity variations, acceleration processes, etc., of cosmic radiation. For the properties of specific cosmic particles or the use of cosmic radiation merely as a source of high-energy particles, see the subcategories *Elementary Particles and Radiations* and *Nuclear Properties and Reactions* of this category, depending on the emphasis.

### Criticality Studies

Basic studies of nuclear criticality. Critical limits of movement and storage of radioactive materials are included in the category HEALTH AND SAFETY. Criticality studies pertaining to reactors are included in the category REACTOR TECHNOLOGY.

### Direct Energy Conversion

Equipment, techniques, and theory of direct-energy conversion, including magnetohydrodynamic cells and thermionic cells.

### Elementary Particles and Radiations

Properties and theory, including interactions with each other. The diffusion of particles and radiations in shielding materials and configurations is included in the subcategory *Shielding* of this category.

### Field Theory and Quantum Mechanics

Basic studies of the behavior and interactions of fields, the kinetics of field-matter systems, and the quantization of energy and energy transfer. Specific applications of field theory and quantum mechanics are found in other subcategories.

### Geophysics

Geomagnetic fields, upper atmosphere physics, and physics of the crust and interior of the earth; this excludes cosmic radiation.

### Low Temperature Physics

Cryogenics, superconductivity, and superfluidity research. Applications are found under categories for the applications.

### Neutron Physics

Experimental and mathematical treatments of neutron absorption, attenuation, moderation, multiplication, scattering, etc., in real and hypothetical media. Such studies conducted for a specified application are categorized according to the application (e.g., the category REACTOR TECHNOLOGY and the subcategories *Criticality Studies* and *Shielding* of this category). Neutron reactions with specific nuclei are included in the subcategory *Nuclear Properties and Reactions* of this category.

### Nuclear Properties and Reactions

Experimental and theoretical studies relating to properties, reactions, and interactions of nuclei.

### Plasma Physics and Thermonuclear Processes

Phenomena of electric discharges; fundamental plasma experiments and theory; theory, design, development, and experimentation relating to controlled release of energy from thermonuclear reactions; and research and theory on electrodynamics and magnetodynamics applicable to plasma studies and thermonuclear processes.

### Shielding

Theoretical and experimental studies relating to the diffusion, attenuation, absorption, and scattering of particles and radiations in shielding materials and configurations. For information on the fabrication of shielding materials and configurations, see the subcategory *Fabrication* of the category METALS, CERAMICS, AND OTHER MATERIALS.

# REACTOR TECHNOLOGY

### General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

### Auxiliaries and Components

Design and construction of auxiliaries, components, control systems, and instrumentation not intended for a specific reactor.

### Criticality Studies

Theoretical and experimental studies of neutron physics and parameters of unspecified reactors.

### Design and Feasibility

Design and feasibility studies of reactor types not designated as power, process heat, production, propulsion, research, or test and not associated with a specific reactor.

### Fuels

Design and theory of fuel elements not associated with a specific reactor. Studies of fuel-element materials are included in the category METALS, CERAMICS, AND OTHER MATERIALS.

### Power and Power-Breeder Reactors

Design, construction, feasibility, operation, and economics of specific reactors and classes of reactors. Also includes auxiliaries, components, and criticality studies for such reactors.

### Process Heat Reactors

Reactors designed to produce heat for uses other than the production of electricity or propulsion. Reactors designed to produce electricity and process heat are included in the subcategory *Power and Power-breeder Reactors* of this category.

### Production Reactors

Design, construction, feasibility, economics, and operation of reactors devoted primarily to the production of fissionable materials or isotopes. Also includes auxiliaries, components, and criticality studies for such reactors.

### Propulsion and Space

Design, construction, feasibility, economics, and operation of reactors for the propulsion of vehicles (land, water, air, and space). Also includes auxiliaries, components, and criticality studies for such reactors. The vehicles themselves are included only if the influence on the reactor is considered.

### Research and Test Reactors

Design, construction, feasibility, economics, and operation of reactors used for radiation-effects studies and other basic research. Also includes auxiliaries, components, and criticality studies for such reactors.

# WASTE DISPOSAL AND PROCESSING

Chemistry and chemical engineering for the storage, disposal, and control of radioactive waste materials, including the treatment of waste materials prior to disposal, such as concentration, neutralization, filtration, or calcination. Safety aspects of radioactive waste handling and disposal are included in the category HEALTH AND SAFETY. Ecological aspects of waste materials are included in the subcategory *Ecology* of the category BIOLOGY AND MEDICINE. Some radiochemical aspects are included in the subcategory *Radiation Chemistry and Radiochemistry* of the category

**CHEMISTRY. Fuel-element processing is included in the subcategory *Separation Processes and Procedures* of the category CHEMISTRY.**

## GENERAL AND MISCELLANEOUS

**This category, for the most part, contains abstracts of research and development reports of the U. S. Atomic Energy Commission and its contractors that are essentially nonnuclear in nature or are outside the scope of the other categories in *NSA*. Such abstracts have been included in *Research and Development Abstracts of the USAEC*. *RDA* was discontinued after issue number 8.**

**Additionally, both AEC and non-AEC originated broad summary type documents with diverse subject matter will be found under this category.**

# Appendix II

# JOURNALS REGULARLY SCANNED

***Acad. Rep. Populare Romine, Filiala Iasi, Studii Cercetari Stiint., Fiz. Stiinte Tehn.***
*Academia Republicii Populare Romine, Filiala Iasi, Studii si Cercetari Stiintifice, Fizica si Stiinte Tehnice *(Romania)*

***Acad. Rep. Populare Romine, Studii Cercetari Fiz.***
*Academia Republicii Populare Romine, Institutul de Fizica Atomica si Institutul de Fizica, Studii si Cercetari de Fizica *(Romania)*

***Acta Anat.***
*Acta Anatomica *(Switzerland)*

***Acta Biochim. Polon. (English Transl.)***
*Acta Biochimica Polonica (English Translation) *(Poland)*

***Acta Chem. Scand.***
*Acta Chemica Scandinavica *(Denmark)*

***Acta Chim. Acad. Sci. Hung.***
*Acta Chimica Academiae Scientiarum Hungaricae *(Hungary)*

***Acta Cryst.***
*Acta Crystallographica *(Denmark)*

***Acta Cytol.***
*Acta Cytologica *(U. S.)*

***Acta Geophys. Polon.***
*Acta Geophysica Polonica *(Poland)*

***Acta Gerontol.***
*Acta Gerontologica *(Italy)*

***Acta Gynaecol. Obstet. Hispano Lusitana***
*Acta Gynaecologica et Obstetrica Hispano Lusitana *(Portugal)*

***Acta Histochem.***
*Acta Histochemica *(Germany)*

***Acta Isotopica***
*Acta Isotopica *(Italy)*

***Acta Med. Hidalguense***
*Acta Medica Hidalguense *(Mexico)*

***Acta Med. Iranica***
*Acta Medica Iranica *(Iran)*

***Acta Med. Okayama***
*Acta Medicinae Okayama *(Japan)*

***Acta Med. Polona***
*Acta Medica Polona *(Poland)*

***Acta Met.***
*Acta Metallurgica *(U. S.)*

***Acta Neurol. Latinoam.***
*Acta Neurologia Latinoamericana *(Uruguay)*

***Acta Neuropsiquiat. Arg.***
*Acta Neuropsiquiatrica Argentina *(Argentina)*

***Acta Oncol.***
*Acta Oncologica *(Spain)*

***Acta Paediat.***
*Acta Paediatrica *(Sweden)*

***Acta Pathol. Japon.***
*Acta Pathologica Japonica *(Japan)*

***Acta Phys. Acad. Sci. Hung.***
*Acta Physica Academiae Scientiarum Hungaricae *(Hungary)*

***Acta Phys. Austriaca***
*Acta Physica Austriaca *(Austria)*

***Acta Physiol. Pharmacol. Neerl.***
*Acta Physiologica et Pharmacologica Neerlandica *(Netherlands)*

***Acta Physiol. Polon.***
*Acta Physiologica Polonica *(Poland)*

***Acta Phys. Polon.***
*Acta Physica Polonica *(Poland)*

***Acta Phys. Sinica***
Acta Physica Sinica
**see *Wu Li Hsueh Pao***

***Acta Radiol. Diagnosis***
*Acta Radiologica. Diagnosis *(Sweden)*

***Acta Radiol. Therapy, Phys., Biol.***
*Acta Radiologica. Therapy, Physics, Biology *(Sweden)*

***Acta Rheumatol. Scand.***
*Acta Rheumatologica Scandinavica *(Sweden)*

***Actas Dermo-Sifilog.***
*Actas Dermo-Sifilograficas *(Spain)*

***Acta Soc. Med. Upsalien.***
*Acta Societatis Medicorum Upsaliensis *(Sweden)*

***Acta Unio Intern. Contra Cancrum***
*Acta Unio Internationalis Contra Cancrum *(Belgium)*

***Acta Virol. (Prague)***
*Acta Virologica (Prague) *(Czechoslovakia)*

***Advan. Energy Conversion***
*Advanced Energy Conversion *(England)*

***Advan. Phys.***
*Advances in Physics *(England)*

***A E G Mitt.***
*A E G Mitteilungen *(Germany)*

***AEI (Assoc. Elec. Ind.) Eng.***
*AEI (Associated Electrical Industries) Engineering *(England)*

***Afrique Franc. Chir.***
*Afrique Francaise Chirurgicale *(Algeria)*

***Aggiorn. Mal. Infezione***
*Aggiornamenti sulle Malattie da Infezione *(Italy)*

***Agron. Lusitana***
*Agronomia Lusitana *(Portugal)*

***AIAA (Am. Inst. Aeron. Astronaut.) J.***
*AIAA (American Institute of Aeronautics and Astronautics) Journal (combining the ARS Journal and the Journal of Aerospace Sciences) *(U. S.)*

***A.I.Ch.E. (Am. Inst. Chem. Engrs.) J.***
*A.I.Ch.E. (American Institute of Chemical Engineers) Journal *(U. S.)*

***Alexandria Med. J.***
*Alexandria Medical Journal, The *(Egypt)*

***Algerie Med.***
*Algerie Medicale *(Algeria)*

***Am. Ceram. Soc. Bull.***
*American Ceramic Society Bulletin, The *(U. S.)*

***Am. Ind. Hyg. Assoc. J.***
*American Industrial Hygiene Association Journal *(U. S.)*

***Am. J. Botany***
*American Journal of Botany *(U. S.)*

***Am. J. Clin. Pathol.***
*American Journal of Clinical Pathology *(U. S.)*

***Am. J. Human Genet.***
*American Journal of Human Genetics, The *(U. S.)*

***Am. J. Pathol.***
*American Journal of Pathology, The *(U. S.)*

**Am. J. Phys.**
*American Journal of Physics *(U. S.)*
**Am. J. Physiol.**
*American Journal of Physiology, The *(U. S.)*
**Am. J. Roentgenol., Radium Therapy Nucl. Med.**
*American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, The *(U. S.)*
**Am. Mineralogist**
*American Mineralogist, The *(U. S.)*
**Am. Naturalist**
*American Naturalist *(U. S.)*
**Am. Soc. Metals, Trans. Quart.**
*American Society for Metals, Transactions Quarterly *(U. S.)*
**Anais Acad. Brasil. Cienc.**
*Anais da Academia Brasileira de Ciencias *(Brazil)*
**Anais Brasil. Dermatol. Sifilog.**
*Anais Brasileiros de Dermatologia e Sifilografia *(Brazil)*
**Anais Brasil. Ginecol. (Rio de Janeiro)**
*Anais Brasileiros de Ginecologia (Rio de Janeiro) *(Brazil)*
**Anais Inst. Med. Trop. (Lisbon)**
*Anais Instituto de Medicina Tropical (Lisbon) *(Portugal)*
**Anal. Biochem.**
*Analytical Biochemistry *(U. S.)*
**Anal. Chem.**
*Analytical Chemistry *(U. S.)*
**Anal. Chim. Acta**
*Analytica Chimica Acta *(Netherlands)*
**Anales Hosp. Militar Central (Lima, Peru)**
*Anales del Hospitel Militar Central (Lima, Peru) *(Peru)*
**Anales Inst. Corachan (Barcelona)**
*Anales del Instituto Corachan (Barcelona) *(Spain)*
**Anales Inst. Oncol. "Angel H. Roffo"**
*Anales del Instituto de Oncologia "Angel H. Roffo" *(Argentina)*
**Anales Med. Cir.**
*Anales de Medicina y Cirugia *(Spain)*
**Anales Real Acad. Nacl. Med. (Madrid)**
*Anales de la Real Academia Nacional de Medicina (Madrid) *(Spain)*
**Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A**
*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie A *(Spain)*
**Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B**
*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie B *(Spain)*
**Anales Soc. Cient. Arg.**
*Anales de la Sociedad Cientifica Argentina *(Argentina)*
**Analyst**
*Analyst, The *(England)*
**Angiologia (Barcelona)**
*Angiologia (Barcelona) *(Spain)*
**Ann. Acad. Sci. Fennicae, Ser. A VI**
*Annales Academiae Scientiarum Fennicae, Series A VI. Physica *(Finland)*
**Ann. Allergy**
*Annals of Allergy *(U. S.)*
**Ann. Biochem. Exptl. Med. (Calcutta)**
*Annals of Biochemistry and Experimental Medicine (Calcutta) *(India)*
**Ann. Chir. Gynaecol. Fenniae**
*Annales Chirurgiae et Gynaecologiae Fenniae *(Finland)*
**Ann. Inst. Henri Poincare**
*Annales de l'Institut Henri Poincare *(France)*
**Ann. Intern. Geophys. Yr.**
*Annals of the International Geophysical Year *(England)*
**Ann. N. Y. Acad. Sci.**
*Annals of the New York Academy of Sciences *(U. S.)*
**Ann. Occupational Hyg.**
*Annals of Occupational Hygiene *(England)*
**Ann. Ostet. Ginecol.**
*Annali di Ostetricia e Ginecologia *(Italy)*
**Ann. Paediat. Fenniae**
*Annales Paediatriae Fenniae *(Finland)*
**Ann. Paediat. Japon.**
*Annales Paediatrici Japonici, Kioto Universitatis *(Japan)*
**Ann. Phys. (N. Y.)**
*Annals of Physics (New York) *(U. S.)*
**Ann. Phys. (Paris)**
*Annales de Physique (Paris) *(France)*
**Ann. Physik**
*Annalen der Physik *(Germany)*
**Ann. Radioelec.**
*Annales de Radioelectricite *(France)*
**Ann. Radiol.**
*Annales de Radiologie *(France)*
**Ann. Rept. Radiation Center Osaka Prefect.**
*Annual Report of the Radiation Center of Osaka Prefecture *(Japan)*
**Ann. Rev. Nucl. Sci.**
*Annual Review of Nuclear Science *(U. S.)*
**Ann. Rev. Phys. Chem.**
*Annual Review of Physical Chemistry *(U. S.)*
**Ann. Rheumatic Diseases**
*Annals of the Rheumatic Diseases *(England)*
**Ann. Sclavo**
*Annali Sclavo *(Italy)*
**Ann. Soc. Sci. Bruxelles. Ser. I**
*Annales de la Societe Scientifique de Bruxelles. Serie I *(Belgium)*
**Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. AA**
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio AA *(Poland)*
**Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. D**
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio D *(Poland)*
**Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. E**
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio E *(Poland)*
**Anotaciones Pediat. (Medellin, Colombia)**
*Anotaciones Pediatricas (Medellin, Colombia) *(Colombia)*
**APCA (Air Pollution Control Assoc.) Abstr.**
*APCA (Air Pollution Control Association) Abstracts *(U. S.)*
**Appl. Mech. Rev.**
*Applied Mechanics Reviews *(U. S.)*
**Appl. Microbiol.**
*Applied Microbiology *(U. S.)*
**Appl. Opt.**
*Applied Optics *(U. S.)*
**Appl. Phys. Letters**
*Applied Physics Letters *(U. S.)*
**Appl. Sci. Res., Sect. A**
*Applied Scientific Research, Section A *(Netherlands)*
**Appl. Sci. Res., Sect. B**
*Applied Scientific Research, Section B *(Netherlands)*
**Appl. Spectry.**
*Applied Spectroscopy *(U. S.)*
**Arbok Univ. Bergen, Mat.-Nat. Ser.**
*Arbok for Universitetet i Bergen, Matematikk-Naturvitenskap Serie *(Norway)*
**Arch. Anat. Microscop. Morphol. Exptl.**
*Archives d'Anatomie Microscopique et de Morphologie Experimentale *(France)*
**Arch. Automat. Telemech.**
*Archiwum Automatyki i Telemechaniki *(Poland)*
**Arch. Biochem. Biophys.**
*Archives of Biochemistry and Biophysics *(U. S.)*
**Arch. Biol. (Liege)**
*Archives de Biologie (Liege) *(Belgium)*
**Arch. Bodowy Maszyn**
*Archiwum Bodowy Maszyn *(Poland)*
**Arch. Environ. Health**
*Archives of Environmental Health (formerly A.M.A. Archives of Industrial Health) *(U. S.)*

**Arch. Hosp. Univ. (Havana)**
*Archivos de Hospitales Universitarios (Havana) (formerly Archivos del Hospital Universitario) *(Cuba)*

**Arch. Hosp. Vargas (Caracas)**
*Archivos del Hospital Vargas (Caracas) *(Venezuela)*

**Arch. Hutnictwa**
*Archiwum Hutnictwa *(Poland)*

**Arch. Hyg. Bakteriol.**
*Archiv fuer Hygiene und Bakteriologie *(Germany)*

**Arch. Immunol. Terapii Doswiadczalnej**
*Archiwum Immunologii i Terapii Doswiadczalnej *(Poland)*

**Arch. Immunol. Therap. Exptl.**
Archivum Immunologicae et Therapiae Experimentalis
*see Arch. Immunol. Terapii Doswiadczalnej*

**Arch. Interam. Rheumatol.**
*Archives of Interamerican Rheumatology *(Brazil)*

**Arch. Intern. Pharmacodyn.**
*Archives Internationales de Pharmacodynamie et de Therapie *(Belgium)*

**Arch. Ital. Biol.**
*Archives Italiennes de Biologie *(Italy)*

**Arch. Med. Mex.**
*Archivos Medicos Mexicanos *(Mexico)*

**Arch. Peru. Patol. Clin. (Lima)**
*Archivos Peruanos de Pathologia y Clinica (Lima) *(Peru)*

**Arch. Roumaines Pathol. Exptl. Microbiol.**
*Archives Roumaines de Pathologie Experimentale et de Microbiologie *(France)*

**Arch. Sci. (Geneva)**
*Archives des Sciences (Geneva) *(Switzerland)*

**Arch. Soc. Estud. Clin. Habana**
*Archivos de la Sociedad de Estudios Clinicos de la Habana *(Cuba)*

**Arch. Venezolanos Patol. Trop. Parasitol. Med.**
*Archivos Venezolanos de Patologia Tropical y Parasitologia Medica *(Venezuela)*

**Argonne Natl. Lab. Rev.**
*Argonne National Laboratory Reviews (supersedes News-Bulletin International (Argonne National Laboratory)) *(U. S.)*

**Arkiv Fysik**
*Arkiv for Fysik *(Sweden)*

**Arkiv Fys. Seminar Trondheim**
*Arkiv for det Fysiske Seminar i Trodheim *(Norway)*

**Arkiv Kemi**
*Arkiv for Kemi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*

**Arquiv. Anat. Antropol. (Lisbon)**
*Arquivo de Anatomia e Antropologia (Lisbon) *(Portugal)*

**Arquiv. Brasil. Cardiol.**
*Arquivos Brasileiros de Cardiologia *(Brazil)*

**Arquiv. Dermatol. Sifilig. Sao Paulo**
*Arquivos de Dermatologia e Sifiligrafia de Sao Paulo *(Brazil)*

**Arquiv. I.B.I.T. (Inst. Brasil. Invest. Tuberc.)**
*Arquivos do I.B.I.T. (Instituto Brasileiro para Investigacao da Tuberculose) *(Brazil)*

**Arquiv. Mineiros Leprol.**
*Arquivos Mineiros de Leprologia *(Brazil)*

**Arquiv. Patol. (Lisbon)**
*Arquivos de Patologia (Lisbon) *(Portugal)*

**Arquiv. Tisiol.**
*Arquivos de Tisiologia *(Portugal)*

**Arthritis Rheumat.**
*Arthritis and Rheumatism *(U. S.)*

**Astronaut. Acta**
*Astronautica Acta *(Austria)*

**Astronaut. Aeronaut.**
*Astronautics & Aeronautics (formerly Astronautics and Aerospace Engineering) *(U. S.)*

**Astronaut. Aerospace Eng.**
*Astronautics and Aerospace Engineering (combining Astronautics and Aerospace Engineering) *(U. S.)*

**Astrophys. J.**
*Astrophysical Journal, The *(U. S.)*

**Astrophys. J., Suppl. Ser.**
*Astrophysical Journal, The, Supplement Series *(U. S.)*

**Ateneo Parmense**
*Ateneo Parmense, L' *(Italy)*

**At. Energ. (USSR)**
*Atomnaya Energiya? *(U.S.S.R.)*

**At. Energy Australia**
*Atomic Energy in Australia *(Australia)*

**At. Energy Rev.**
*Atomic Energy Review *(Austria)*

**At. Kozlemen.**
*Atomki Kozlemenyek (formerly carried under the title: Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek) *(Hungary)*

**Atomdokumentation**
*Atomdokumentation. Selektiv Litteraturlista *(Sweden)*

**Atomes (Paris)**
*Atomes (Paris) *(France)*

**Atomics**
*Atomics *(U. S.)*

**Atomkernenergie**
*Atomkernenergie (formerly Atomenergie) *(Germany)*

**Atomlight**
*Atomlight *(U. S.)*

**Atompraxis**
*Atompraxis *(Germany)*

**Atomwirtschaft**
*Atomwirtschaft, Die *(Germany)*

**Atoomenergie Haar Toepassingen**
*Atoomenergie en Haar Toepassingen (formerly RCN Bulletin) *(Netherlands)*

**At. Strom**
*Atom und Strom *(Germany)*

**Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat.**
*Atti della Accademia Nazionale dei Lincei. Rendiconti, Classe di Scienze Fisiche, Matematiche e Naturali *(Italy)*

**Atti Accad. Sci. Torino: I. Classe Sci. Fis., Mat. Nat.**
*Atti della Accademia delle Scienze di Torino. Part I. Classe Scienze Fisiche, Matematiche e Naturali *(Italy)*

**Atti Assoc. Genet. Ital.**
*Atti Associazone Genetica Italiana *(Italy)*

**Atti Soc. Nat. Mat. Modena**
*Atti della Societa dei Naturalisti e Matematici di Modena *(Italy)*

**Australian J. Appl. Sci.**
*Australian Journal of Applied Science *(Australia)*

**Australian J. Chem.**
*Australian Journal of Chemistry *(Australia)*

**Australian J. Phys.**
*Australian Journal of Physics *(Australia)*

**Automazione Automatismi**
*Automazione e Automatismi *(Italy)*

**Automazione Strumentazione**
*Automazione e Strumentazione *(Italy)*

**Bacteriol. Rev.**
*Bacteriological Reviews *(U. S.)*

**Battelle Tech. Rev.**
*Battelle Technical Review *(U. S.)*

**Beitr. Pathol. Anat. Allgem. Pathol.**
*Beitraege zur Pathologischen Anatomie und zur Allgemeinen Pathologie *(Germany)*

**Ber. Bunsenges. Physik. Chem.**
*Berichte der Bunsengesellschaft fuer Physikalische Chemie (formerly Zeitschrift fuer Elektrochemie) *(Germany)*

**Ber. Deut. Keram. Ges.**
*Berichte der Deutschen Keramischen Gesellschaft e. V. *(Germany)*

**Ber. Oberhess. Ges. Natur- Heilk. Giessen, Naturw. Abt.**
*Bericht der Oberhessischen Gesellschaft fuer Natur- und Heilkunde zu Giessen, Naturwissenschaftliche Abteilung *(Germany)*

***Biochem. Biophys. Res. Commun.***
*Biochemical and Biophysical Research Communications *(U. S.)*
***Biochemistry***
*Biochemistry *(U. S.)*
***Biochemistry (USSR) (English Transl.)***
*Biochemistry (USSR) (English Translation of Biokhimiya) *(U. S.)*
***Biochem. J.***
*Biochemical Journal *(England)*
***Biochem. Pharmacol.***
*Biochemical Pharmacology *(England)*
***Biochim. Biophys. Acta***
*Biochimica et Biophysica Acta *(U. S.)*
***Biol. Neonatorum***
*Biologia Neonatorum *(Switzerland)*
***Biophysik***
*Biophysik *(Germany)*
***Biophys. J.***
*Biophysical Journal *(U. S.)*
***Biophys. J., Suppl.***
*Biophysical Journal, Supplement *(U. S.)*
***Blood***
*Blood. The Journal of Hematology *(U. S.)*
***Boei Eisei***
*Boei Eisei (National Defense Medical Journal) *(Japan)*
***Bol. Asoc. Med. Puerto Rico***
*Boletin de la Asociacion Medica de Puerto Rico *(Puerto Rico)*
***Bol. Hosp. Oftalmol. Nuestra Senora de la Luz***
*Boletin del Hospital Oftalmologico de Nuestra Senora de la Luz *(Mexico)*
***Bol. Inform. Junta Control Energia At. (Peru)***
*Boletin de Informaciones de la Junta de Control de Energia Atomica *(Peru)*
***Bol. Inst. Estud. Med. Biol. (Mex.)***
*Boletin del Instituto de Estudios Medicos y Biologicos *(Mexico)*
***Boll. Assoc. Nazl. Ital. Ing. Nucl.***
*Bollettino dell Associazione Nazionale Italiana di Ingegneria Nucleare *(Italy)*
***Boll. Ist. Sieroterap. Milan.***
*Bollettino dell'Istituto Sieroterapico Milanese *(Italy)*
***Bol. Soc. Cubana Dermatol. Sifilog.***
*Boletin de la Sociedad Cubana de Dermatologia y Sifilografia *(Cuba)*
***Bol. Soc. Med. Centro Materno "Gral. Maximino Avila Camacho"***
*Boletin de la Sociedad Medica del Centro Maternoo "Gral. Maximino Avila Camacho" *(Mexico)*
***Bol. Trab. Soc. Cir. Buenos Aires***
*Boletines y Trabajos; Sociedad de Cirugia de Buenos Aires *(Argentina)*
***Bol. Univ. Parana, Fis. Teorica***
*Boletim da Universidade do Parana, Fisica Teorica *(Brazil)*
***Botan. Bull. Acad. Sinica (Taiwan)***
*Botanical Bulletin of Academia Sinica (Taiwan) *(China)*
***Botan. Gaz.***
*Botanical Gazette *(U. S.)*
***Brennstoff-Waerme-Kraft***
*Brennstoff-Waerme-Kraft *(Germany)*
***Brigham Young Univ. Sci. Bull., Biol. Ser.***
*Brigham Young University Science Bulletin, Biological Series *(U. S.)*
***Brit. Chem. Eng.***
*British Chemical Engineering *(England)*
***Brit. Columbia Med. J.***
*British Columbia Medical Journal *(Canada)*
***Brit. J. Appl. Phys.***
*British Journal of Applied Physics *(England)*
***Brit. J. Cancer***
*British Journal of Cancer *(England)*
***Brit. J. Radiol.***
*British Journal of Radiology *(England)*

***Brown Boveri Rev.***
*Brown Boveri Review, The *(Switzerland)*
***Bul. Inst. Politeh. Bucuresti***
*Buletinul Institutului Politehnic Bucuresti *(Romania)*
***Bul. Inst. Politeh. Iasi***
*Buletinul Institutului Politehnic din Iasi *(Romania)*
***Bull. Acad. Polon. Sci., Ser. Sci. Chim.***
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Chimiques *(Poland)*
***Bull. Acad. Polon. Sci., Ser. Sci. Geol. Geograph.***
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Geologiques et Geographiques *(Poland)*
***Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys.***
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences, Mathematiques, Astronomiques et Physiques *(Poland)*
***Bull. Acad. Polon. Sci., Ser. Sci., Tech.***
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Techniques *(Poland)*
***Bull. Atmospheric Radioactivity (Japan)***
Bulletin of the Atmospheric Radioactivity (Japan) ***see Taiki Hoshano Kansoku Seiseki***
***Bull. Chem. Soc. Japan***
*Bulletin of the Chemical Society of Japan *(Japan)*
***Bull. Classe Sci., Acad. Roy. Belg.***
*Bulletin de la Classe des Sciences, Academie Royale de Belgique *(Belgium)*
***Bull. Electrotech. Lab. (Tokyo)***
Bulletin of the Electrotechnical Laboratory (Tokyo) ***see Denki Shikensho Iho***
***Bull. Exptl. Biol. Med. (USSR) (English Transl.)***
*Bulletin of Experimental Biology and Medicine (USSR) (English Translation of Byulleten Eksperimental'noi Biologii Meditsiny) *(U. S.)*
***Bull. Heart Inst., Japan***
*Bulletin of the Heart Institute, Japan *(Japan)*
***Bull. Hosp. Joint Diseases***
*Bulletin of the Hospital for Joint Diseases *(U. S.)*
***Bull. Inform. Assoc. Belge Develop. Pacifique Energie At.***
*Bulletin d'Information de l'Association Belge pour le Developpement Pacifique de l'Energie Atomique *(Belgium)*
***Bull. Inform. Sci. Tech. (Paris)***
*Bulletin d'Information Scientifique et Technique (Paris) *(France)*
***Bull. Inst. Chem., Acad. Sinica***
*Bulletin of the Institute of Chemistry, Academia Sinica *(China)*
***Bull. Inst. Chem. Res., Kyoto Univ.***
*Bulletin of the Institute for Chemical Research, Kyoto University *(Japan)*
***Bull. Inst. Nucl. Sci. "Boris Kidrich" (Belgrade)***
*Bulletin of the Institute of Nuclear Science "Boris Kidrich" (Belgrade) *(Yugoslavia)*
***Bull. Rheumatic Diseases***
*Bulletin on Rheumatic Diseases *(U. S.)*
***Bull. Schweiz. Akad. Med. Wiss.***
*Bulletin der Schweizerischen Akademie der Medizinischen Wissenschaften *(Switzerland)*
***Bull. Sci., Conseil Acad. RPF Yougoslavie***
*Bulletin Scientifique, Conseil des Academies de la RPF Yougoslavie *(Yugoslavia)*
***Bull. Soc. Chim. Belges***
*Bulletin des Societes Chimiques Belges *(Belgium)*
***Bull. Soc. Chim. France***
*Bulletin de la Societe Chimique de France *(France)*
***Bull. Soc. Roy. Belge Gynecol. Obstet.***
*Bulletin de la Societe Royale Belge de Gynecologie et d'Obstetrique *(Belgium)*
***Bull. Soc. Roy. Sci. Liege***
*Bulletin de la Societe Royale des Sciences de Liege *(Belgium)*
***Bull. Soc. Vaudoise Sci. Nat.***
*Bulletin de la Societe Vaudoise des Sciences Naturelles *(Switzerland)*

**Bull. Tokyo Inst. Technol., Spec. No.**
*Bulletin of the Tokyo Institute of Technology, Special Number *(Japan)*

**Bunseki Kagaku**
*Bunseki Kagaku (Japan Analyst) *(Japan)*

**Burma Med. J.**
*Burma Medical Journal *(Burma)*

**Cahiers Phys.**
*Cahiers de Physique *(France)*

**Calif. Med.**
*California Medicine *(U. S.)*

**Calore**
*Calore, Il *(Italy)*

**Cancer**
*Cancer *(U. S.)*

**Cancer Res.**
*Cancer Research *(U. S.)*

**Can. Chem. Process.**
*Canadian Chemical Processing *(Canada)*

**Can. J. Biochem.**
*Canadian Journal of Biochemistry (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*

**Can. J. Chem.**
*Canadian Journal of Chemistry *(Canada)*

**Can. J. Chem. Eng.**
*Canadian Journal of Chemical Engineering (formerly Canadian Journal of Technology) *(Canada)*

**Can. J. Genet. Cytol.**
*Canadian Journal of Genetics and Cytology *(Canada)*

**Can. J. Phys.**
*Canadian Journal of Physics *(Canada)*

**Can. J. Physiol. Pharmacol.**
*Canadian Journal of Physiology and Pharmacology (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*

**Can. Met. Quart.**
*Canadian Metallurgical Quarterly *(Canada)*

**Can. Nucl. Technol.**
*Canadian Nuclear Technology *(Canada)*

**Cardiologia**
*Cardiologia *(Switzerland)*

**Caryologia**
*Caryologia *(Italy)*

**CENUSA (Bol. Centrales Nucl., Soc. Anon.)**
*CENUSA (Boletin de Centrales Nucleares, Sociedad Anonima) *(Spain)*

**CERN Courier**
*CERN Courier *(Switzerland)*

**Cesk. Casopis Fys.**
*Ceskoslovensky Casopis pro Fysiku *(Czechoslovakia)*

**Chem. Anal. (Warsaw)**
*Chemia Analityczna (Warsaw) *(Poland)*

**Chem. Bull. (Peking)**
Chemical Bulletin (Peking)
*see Hua Hsueh Tung Pao*

**Chem. Eng. Progr.**
*Chemical Engineering Progress *(U. S.)*

**Chem. Eng. Sci.**
*Chemical Engineering Science *(U. S.)*

**Chem. Ind. (London)**
*Chemistry & Industry (London) *(England)*

**Chemist-Analyst**
*Chemist-Analyst, The *(U. S.)*

**Chem. Listy**
*Chemicke Listy *(Czechoslovakia)*

**Chem. Process Eng.**
*Chemical & Process Engineering (including Atomic World) *(England)*

**Chem. Rev.**
*Chemical Reviews *(U. S.)*

**Chem. Tech. (Leipzig)**
*Chemische Technik, VEB Deutscher Verlag fuer Grundstoffindustrie, Leipzig *(Germany)*

**Chim. Anal.**
*Chimie Analytique (Paris) *(France)*

**Chimia (Aarau)**
*Chimia (Aarau) *(Switzerland)*

**Chinese J. Phys. (Taiwan)**
*Chinese Journal of Physics (Taiwan) *(China)*

**Chromosoma**
*Chromosoma *(Germany)*

**Chung Kuo K'o Hsueh**
Chung Kuo K'o Hsueh
*see Sci. Sinica (Peking)*

**Ciencia Tec. (Buenos Aires)**
*Ciencia y Tecnica (Buenos Aires) *(Argentina)*

**Cir. Cirujanos**
*Cirugia y Cirujanos *(Mexico)*

**Cir. Ginecol. Urol.**
*Cirugia, Ginecologia, y Urologia *(Spain)*

**Clin. Chem.**
*Clinical Chemistry *(U. S.)*

**Clin. Chim. Acta**
*Clinica Chimica Acta *(Netherlands)*

**Clin. Res.**
*Clinical Research *(U. S.)*

**Cobalt**
*Cobalt *(Belgium) (U. S.)*

**Collection Czech. Chem. Commun.**
*Collection of Czechoslovak Chemical Communications *(Czechoslovakia)*

**Comit. Nazl. Energia Nucl., Notiziario**
*Comitato Nazionale per l'Energia Nucleare, Notiziario *(Italy)*

**Compt. Rend.**
*Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences *(France)*

**Compt. Rend. Soc. Biol.**
*Comptes Rendus des Seances de la Societe de Biologie et de ses Filiales *(France)*

**Compt. Rend. Soc. Franc. Gynecol.**
*Comptes Rendus de la Societe Francaise de Gynecologie *(France)*

**Contemp. Phys.**
*Contemporary Physics *(England)*

**Contrib. Cient., Univ. Buenos Aires, Fac. Cienc. Exact. Nat., Ser. Fis.**
*Contribuciones Cientificas, Universidad de Buenos Aires, Faculdad de Ciencias Exactas y Naturales, Serie Fisica *(Argentina)*

**Corrosion**
*Corrosion *(U. S.)*

**Corrosion Anti-Corrosion**
*Corrosion et Anti-Corrosion *(France)*

**Corrosion Sci.**
*Corrosion Science *(U. S.)*

**Croat. Chem. Acta**
*Croatica Chemica Acta *(Yugoslavia)*

**Crop Sci.**
*Crop Science *(U. S.)*

**Cryogenics**
*Cryogenics *(England)*

**Current Sci. (India)**
*Current Science *(India)*

**Cytogenetics**
*Cytogenetics *(Switzerland)*

**Czech. J. Phys.**
*Czechoslovak Journal of Physics *(Czechoslovakia)*

**Danish Med. Bull.**
*Danish Medical Bulletin *(Denmark)*

**Denki Shikensho Iho**
*Denki Shikensho Iho (Bulletin of the Electrotechnical Laboratory (Tokyo)) *(Japan)*

**Dermatologica**
*Dermatologica *(Switzerland)*
**Deut. Z. Verdauungs- Stoffwechselkrankh.**
*Deutsche Zeitschrift fuer Verdauungs-und Stoffwechselkrankheiten *(Germany)*
**Develop. Biol.**
*Developmental Biology *(U. S.)*
**Discovery**
*Discovery *(England)*
**Dissertation Abstr.**
*Dissertation Abstracts *(U. S.)*
**Dokl. Akad. Nauk SSSR**
*Doklady Akademii Nauk SSSR† *(U.S.S.R.)*
**Dopovidi Akad. Nauk Ukr. RSR**
*Dopovidi Akademii Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*
**Econ. Geol.**
*Economic Geology and the Bulletin of the Society of Economic Geologists *(U. S.)*
**Ekol. Polska, Ser. B**
*Ekologia Polska, Seria B *(Poland)*
**Elec. Export Rev.**
*Electrical Export Review *(England)*
**Electricite**
*Electricite *(France)*
**Electrochim. Acta**
*Electrochimica Acta *(U. S.)*
**Electron. Eng.**
*Electronic Engineering Incorporating Electronics, Television and Short Wave World *(England)*
**Electronics**
* Electronics *(U. S.)*
**Electron. Weekly**
*Electronics Weekly *(England)*
**Elektrizitaetswirtschaft**
*Elektrizitaetswirtschaft *(Germany)*
**Endeavour**
*Endeavour *(England)*
**Endocrinology**
*Endocrinology *(U. S.)*
**Energia Atomtech.**
*Energia es Atomtechnika *(Hungary)*
**Energia Nucl. (Madrid)**
*Energia Nuclear (Madrid) *(Spain)*
**Energia Nucl. (Milan)**
*Energia Nucleare (Milan) *(Italy)*
**Energie Nucl.**
*Energie Nucleaire *(France)*
**Energy Intern.**
*Energy International *(England)*
**Ergeb. Allgem. Pathol. Pathol. Anat.**
*Ergebnisse der Allgemeinen Pathologie und Pathologischen Anatomie *(Germany)*
**Euratom Bull.**
*Euratom Bulletin (Bulletin of the European Atomic Energy Community) *(Netherlands)*
**Excerpta Med., Sect. XXIII**
*Excerpta Medica, Section XXIII *(Netherlands)*
**Experientia**
*Experientia *(Switzerland)*
**Expti. Cell Res.**
*Experimental Cell Research *(U. S.)*
**Expti. Mol. Pathol.**
*Experimental and Molecular Pathology *(U. S.)*
**Expti. Tech. Physik**
*Experimentelle Technik der Physik *(Germany)*
**Federation Proc.**
*Federation Proceedings *(U. S.)*
**Federation Proc., Transl. Suppl.**
*Federation Proceedings, Translation Supplement *(U. S.)*
**Fiz. Metal. i Metalloved.**
*Fizika Metallov i Metallovedeniya, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*
**Fiz. Szemle**
*Fizikai Szemle *(Hungary)*
**Folia Biol. (Prague)**
*Folia Biologica (Prague) *(Czechoslovakia)*
**Folia Clin. Intern.**
*Folia Clinica Internacional *(Spain)*
**Folia Haematol. (Frankfurt)**
*Folia Haematologica (Frankfurt) *(Germany)*
**Folia Med. (Naples)**
*Folia Medica (Naples) *(Italy)*
**Food Irradiation**
*Food Irradiation *(France)*
**Fortschr. Chem. Forsch.**
*Fortschritte der Chemischen Forschung *(Germany)*
**Fortschr. Gebiete Roentgenstrahlen Nuklearmed.**
*Fortschritte auf dem Gebiete der Roentgenstrahlen und der Nuklearmedizin, Diagnostik, Physik, Biologie, Therapie *(Germany)*
**Fortschr. Physik**
*Fortschritte der Physik *(Germany)*
**Gac. Ortoped. Traumatol.**
*Gaceta Ortopedia y Traumatologia *(Mexico)*
**Geburtsh Frauenheilk.**
*Geburtshilfe und Frauenheilkunde *(Germany)*
**G.E.C.J. Sci. Tech.**
*G. E. C. Journal of Science and Technology *(England)*
**G.E.N. (Caracas)**
*G.E.N. (Caracas) *(Venezuela)*
**Gencho Hiroshima Igaku**
*Gencho Hiroshima Igaku (The Hiroshima Medical Journal) *(Japan)*
**Gen. Comp. Endocrinol.**
*General and Comparative Endocrinology *(U. S.)*
**Genetica**
*Genetica *(Netherlands)*
**Genetics**
*Genetics *(U. S.)*
**Genet. Res.**
*Genetical Research *(England)*
**Genshiryoku Kogyo**
*Genshiryoku Kogyo (Nuclear Engineering) *(Japan)*
**Geochim. Cosmochim. Acta**
*Geochimica et Cosmochimica Acta *(England)*
**Geofis. Pura Appl.**
*Geofisica Pura e Applicata *(Italy)*
**Geokhimiya**
*Geokhimiya† *(U.S.S.R.)*
**Geophysics**
*Geophysics *(U. S.)*
**Gerontol. Clin.**
*Gerontologia Clinica *(Switzerland)*
**Gerontologia**
*Gerontologia *(Switzerland)*
**Gigiena i Sanit.**
*Gigiena i Sanitariya *(U. S. S. R.)*
**Ginecol. Obstet. Mex.**
*Ginecologia y Obstetricia de Mexico *(Mexico)*
**Giorn. Gerontol.**
*Giornale di Gerontologia *(Italy)*
**Giorn. Microbiol.**
*Gironale di Microbiologia *(Italy)*
**Glasnik Mat.-Fiz. Astron., Ser. II**
*Glasnik Matematicko-Fizicki i Astronomski, Serija II *(Yugoslavia)*
**Gunma J. Med. Sci.**
*Gunma Journal of Medical Sciences, The *(Japan)*
**Guy's Hosp. Rept.**
*Guy's Hospital Reports *(England)*
**Health Phys.**
*Health Physics *(U. S.-England)*
**Helv. Chim. Acta**
*Helvetica Chimica Acta *(Switzerland)*

***Helv. Chir. Acta***
*Helvetica Chirurgica Acta *(Switzerland)*
***Helv. Paediat. Acta***
*Helvetica Paediatrica Acta *(Switzerland)*
***Helv. Phys. Acta***
*Helvetica Physica Acta *(Switzerland)*
***Hereditas***
*Hereditas *(Sweden)*
***High Temp. (USSR) (English Transl.)***
*High Temperature (USSR) (English Translation of Teplofizika Vysokikh Temperatur) *(U. S.)*
***Hindustan Antibiot. Bull.***
*Hindustan Antibiotics Bulletin *(India)*
***Hiroshima J. Med. Sci.***
*Hiroshima Journal of Medical Sciences *(Japan)*
***Hiroshima Med. J.***
Hiroshima Medical Journal, The
*see Gencho Hiroshima Igaku*
***Hoshasen Kobunshi***
*Hoshasen Kobunshi (Radiation Research on Polymers) *(Japan)*
***Ho Tsu K'o Hsueh***
*Ho Tsu K'o Hsueh (Nuclear Science) *(China)*
***Hua Hseuh Tung Pao***
*Hua Hseuh Tung Pao (Chemical Bulletin) *(China)*
***Huaxue Tongbao***
Huaxue Tongbao
*see Hua Hseuh Tung Pao*
***I.C.R.S. Med. Rept.***
*I.C.R.S. (Institute of Contemporary Russian Studies) Medical Reports *(U. S.)*
***Idengaku Zasshi***
*Idengaku Zasshi (Japanese Journal of Genetics) *(Japan)*
***IEEE (Inst. Elec. Electron. Engrs.), Spectrum***
*IEEE (Institute of Electrical and Electronics Engineers), Spectrum *(U. S.)*
***IEEE (Inst. Elec. Electron. Engrs.), Trans. Appl. Ind.***
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Applications and Industry *(U. S.)*
***IEEE (Inst. Elec. Electron. Engrs.), Trans. Commun. Electron.***
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Communication and Electronics *(U. S.)*
***IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci.***
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Nuclear Science (formerly IRE (Institute of Radio Engineers), Transactions on Nuclear Science) *(U. S.)*
***IEEE (Inst. Elec. Electron. Engrs.), Trans. Power App. Systems***
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Power Apparatus and Systems *(U. S.)*
***Immunology***
*Immunology *(England)*
***Ind. At.***
*Industries Atomiques *(France)*
***Ind. Chim. Belge***
*Industrie Chimique Belge *(Belgium)*
***Ind. Eng. Chem.***
*Industrial and Engineering Chemistry *(U. S.)*
***Ind. Eng. Chem., Fundamentals***
*Industrial & Engineering Chemistry, Fundamentals *(U. S.)*
***Ind. Eng. Chem., Process Design Develop.***
*Industrial & Engineering Chemistry, Process Design and Development *(U. S.)*
***Ind. Eng. Chem., Prod. Res. Develop.***
*Industrial & Engineering Chemistry, Product Research and Development *(U. S.)*
***Indian J. Chem.***
*Indian Journal of Chemistry *(India)*
***Indian J. Child Health***
*Indian Journal of Child Health, The *(India)*
***Indian J. Exptl. Biol.***
*Indian Journal of Experimental Biology *(India)*
***Indian J. Med. Sci.***
*Indian Journal of Medical Sciences *(India)*
***Indian J. Phys.***
*Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science *(India)*
***Indian J. Pure Appl. Phys.***
*Indian Journal of Pure & Applied Physics *(India)*
***Indian J. Radiol.***
*Indian Journal of Radiology *(India)*
***Indian J. Technol.***
*Indian Journal of Technology (formerly Journal of Scientific and Industrial Research (India), Section D) *(India)*
***Indian Minerals***
*Indian Minerals *(India)*
***Ind. Res.***
*Industrial Research *(U. S.)*
***Infrared Phys.***
*Infrared Physics *(U. S.—England)*
***Ingenioeren***
*Ingenioeren *(Denmark)*
***Inorg. Chem.***
*Inorganic Chemistry *(U. S.)*
***Instr. Nucl. (Paris)***
*Instrumentation Nucleaire (Paris). Supplement au Bulletin d'Informations Scientifiques et Techniques (Paris) *(France)*
***Intern. Arch. Allergy Appl. Immunol.***
*International Archives of Allergy and Applied Immunology *(Switzerland)*
***Intern. At. Energy Agency Bull.***
*International Atomic Energy Agency Bulletin *(Austria)*
***Intern. Chem. Eng.***
*International Chemical Engineering *(U. S.)*
***Intern. J. Air Water Pollution***
*International Journal of Air & Water Pollution (formerly International Journal of Air Pollution) *(England)*
***Intern. J. Appl. Radiation Isotopes***
*International Journal of Applied Radiation and Isotopes *(England)*
***Intern. J. Heat Mass Transfer***
*International Journal of Heat and Mass Transfer *(England)*
***Intern. J. Radiation Biol.***
*International Journal of Radiation Biology and related studies in Physics, Chemistry and Medicine *(England)*
***Intern. Sci. Technol.***
*International Science and Technology *(U. S.)*
***Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR***
*Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk Belorusskoi SSR *(U.S.S.R.)*
***ISA (Instr. Soc. Am.) Trans.***
*ISA (Instrument Society of America) Transactions *(U. S.)*
***Israel J. Chem.***
*Israel Journal of Chemistry (supersedes Bulletin of the Research Council of Israel, Section A: Chemistry) *(Israel)*
***Israel J. Phys.***
*Israel Journal of Physics (supersedes in part Bulletin of the Research Council of Israel, Section F: Mathematics and Physics) *(Israel)*
***Istanbul Univ., Fen Fak. Mecmuasi, Seri C***
*Istanbul Universitesi Fen Fakultesi Mecmuasi: Seri C: Astronomi-Fizik-Kimya *(Turkey)*
***Ital. J. Biochem.***
*Italian Journal of Biochemistry (English edition of Giornale de biochimica) *(Italy)*
***Izmeritel. Tekhn.***
*Izmeritel'naya Tekhnika' *(U.S.S.R.)*
***Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk***
*Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*
***Izv. Akad. Nauk Azerb. SSR, Ser. Fiz. Mat. i Tekhn. Nauk***
*Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk (formerly Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko Tekhnicheskikh i Khimicheskikh Nauk) *(Azerbaidzhan S.S.R.)*

***Izv. Akad. Nauk Est. SSR, Ser. Biol.***
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Biologicheskaya *(Estonian S.S.R.)*

***Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. i Tekhn. Nauk***
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk (formerly Izvestiya Akademii Nauk Estonskoi SSR, Seriya Tekhnicheskikh i Fiziko Matematicheskikh Nauk) *(Estonian S.S.R.)*

***Izv. Akad. Nauk SSSR, Energ. i Transp.***
*Izvestiya Akademii Nauk SSSR, Energetika i Transport (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Energetika i Transport) *(U.S.S.R.)*

***Izv. Akad. Nauk SSSR, Mekhan. i Mashinostr.***
*Izvestiya Akademii Nauk SSSR, Mekhanika i Mashinostroenie (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie) *(U.S.S.R.)*

***Izv. Akad. Nauk SSSR, Met. i Gorn. Delo***
*Izvestiya Akademii Nauk SSSR, Metallurgiya i Gornoe Delo (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metallurgiya i Gornoe Delo) *(U.S.S.R.)*

***Izv. Akad. Nauk SSSR, Ser. Biol.***
*Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*

***Izv. Akad. Nauk SSSR, Ser. Fiz.***
*Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya† *(U.S.S.R.)*

***Izv. Akad. Nauk SSSR, Ser. Geofiz.***
*Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya† *(U.S.S.R.)*

***Izv. Akad. Nauk SSSR, Ser. Khim.***
*Izvestiya Akademii Nauk SSSR, Seriya Khimicheskaya (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Khimicheskikh Nauk) *(U.S.S.R.)*

***Izv. Akad. Nauk SSSR, Tekhn. Kibernetika***
*Izvestiya Akademii Nauk SSSR, Tekhnicheskaya Kibernetika (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Tekhnicheskaya Kibernetika) *(U.S.S.R.)*

***Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk***
*Izvestiya Akademii Nauk Uzbekskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Uzbek S.S.R.)*

***Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Tekhn. Nauk.***
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Tekhnicheskikh Nauk (supersedes in part Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR) *(U.S.S.R.)*

***Izv. Vysshikh Uchebn. Zavedenii, Fiz.***
*Izvestiya Vysshikh Uchebnykh Zavedenii, Fizika *(U.S.S.R.)*

***Izv. Vysshikh Uchebn. Zavedenii, Radiofiz.***
*Izvestiya Vysshikh Uchebnykh Zavednii, Radiofizika† *(U.S.S.R.)*

***Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met.***
*Izvestiya Vysshikh Uchebnykh Zavednii, Tsvetnaya Metallurgiya *(U.S.S.R.)*

***Jaderna Energie***
*Jaderna Energie *(Czechoslovakia)*

***Jahrb. Akad. Wiss. Goettingen***
*Jahrbuch der Akademie der Wissenschaften in Goettingen *(Germany)*

***J. Am. Ceram. Soc.***
*Journal of the American Ceramic Society *(U. S.)*

***J. Am. Chem. Soc.***
*Journal of the American Chemical Society *(U. S.)*

***J. Am. Water Works Assoc.***
*Journal of the American Water Works Association *(U. S.)*

***Japan Analyst***
Japan Analyst
**see *Bunseki Kagaku***

***Japan. Circulation J. (English Ed.)***
*Japanese Circulation Journal (English Edition) *(Japan)*

***Japan. Heart J.***
*Japanese Heart Journal *(Japan)*

***Japan. J. Appl. Phys.***
*Japanese Journal of Applied Physics *(Japan)*

***Japan. J. Genetics***
Japanese Journal of Genetics
**see *Idengaku Zasshi***

***J. Appl. Chem. (London)***
*Journal of Applied Chemistry (London) *(England)*

***J. Appl. Mech.***
*Journal of Applied Mechanics, Transactions of the ASME, Series E *(U. S.)*

***J. Appl. Meteorol.***
*Journal of Applied Meteorology *(U. S.)*

***J. Appl. Phys.***
*Journal of Applied Physics *(U. S.)*

***J. Appl. Physiol.***
*Journal of Applied Physiology *(U. S.)*

***J. Appl. Polymer Sci.***
*Journal of Applied Polymer Science *(U. S.)*

***J. Assoc. Offic. Agr. Chemists***
*Journal of the Association of Official Agricultural Chemists *(U. S.)*

***J. At. Energ. Soc. Japan***
Journal of the Atomic Energy Society of Japan
**see *Nippon Genshiryoku Gakkaishi***

***J. Atmospheric Sci.***
*Journal of the Atmospheric Sciences (formerly the Journal of Meteorology) *(U. S.)*

***J. Atmospheric Terrest. Phys.***
*Journal of Atmospheric and Terrestrial Physics *(U. S.)*

***J. Australian Inst. Metals***
*Journal of the Australian Institute of Metals *(Australia)*

***J. Bacteriol.***
*Journal of Bacteriology *(U. S.)*

***J. Basic Eng.***
*Journal of Basic Engineering, Transactions of the ASME, Series D *(U. S.)*

***J. Belge Radiol.***
*Journal Belge de Radiologie *(Belgium)*

***J. Biol. Chem.***
*Journal of Biological Chemistry, The *(U. S.)*

***J. Brasil. Neurol.***
*Journal Brasileiro de Neurologia *(Brazil)*

***J. Brasil. Psiquiat.***
*Journal Brasileiro de Psiquiatria *(Brazil)*

***J. Brit. Interplanet. Soc.***
*Journal of the British Interplanetary Society *(England)*

***J. Brit. Nucl. Energy Soc.***
*Journal of the British Nuclear Energy Society, The (formerly Journal of the British Nuclear Energy Conference) *(England)*

***J. Cellular Comp. Physiol.***
*Journal of Cellular and Comparative Physiology *(U. S.)*

***J. Chem. Eng. Data***
*Journal of Chemical and Engineering Data *(U. S.)*

***J. Chem. Phys.***
*Journal of Chemical Physics, The *(U. S.)*

***J. Chem. Soc.***
*Journal of the Chemical Society (London) *(England)*

***J. Chem. Soc. Japan***
Journal of the Chemical Society of Japan
**see *Nippon Kagaku Zasshi***

***J. Chem. Soc. Japan, Pure Chem. Sect.***
Journal of the Chemistry Society of Japan, Pure Chemistry Section
**see *Nippon Kagaku Zasshi***

***J. Chim. Phys.***
*Journal de Chimie Physique et de Physicochimie Biologique *(France)*

***J. Chromatog.***
*Journal of Chromatography *(Netherlands)*

***J. Clin. Endrocrinol. Metab.***
*Journal of Clinical Endocrinology and Metabolism, The *(U. S.)*

***J. Clin. Invest.***
*Journal of Clinical Investigation, The *(U. S.)*

***J. Colloid Sci.***
*Journal of Colloid Science *(U. S.)*

***J. Egypt. Med. Assoc.***
*Journal of the Egyptian Medical Association, The *(Egypt)*

***J. Electroanal. Chem.***
*Journal of Electroanalytical Chemistry *(Netherlands)*

***J. Electrochem. Soc.***
*Journal of the Electrochemical Society *(U. S.)*

***J. Electron. Control***
*Journal of Electronics and Control *(U. S.)*

***J. Embryol. Exptl. Morphol.***
*Journal of Embryology and Experimental Morphology *(England)*

***J. Eng. Ind.***
*Journal of Engineering for Industry, Transactions of the ASME, Series B *(U. S.)*

***J. Eng. Power***
*Journal of Engineering for Power, Transactions of the ASME, Series A *(U. S.)*

***J. Exptl. Med.***
*Journal of Experimental Medicine *(U. S.)*

***J. Fluid Mech.***
*Journal of Fluid Mechanics *(U. S.)*

***J. Franklin Inst.***
*Journal of the Franklin Institute *(U. S.)*

***J. Genet.***
*Journal of Genetics *(U. S.)*

***J. Geomagnet. Geoelec.***
*Journal of Geomagnetism and Geoelectricity *(Japan)*

***J. Geophys. Res.***
*Journal of Geophysical Research *(U. S.)*

***J. Gerontol.***
*Journal of Gerontology *(U. S.)*

***J. Heat Transfer***
*Journal of Heat Transfer, Transactions of the ASME, Series C *(U. S.)*

***Jikeikai Med. J.***
*Jikeikai Medical Journal *(Japan)*

***J. Immunol.***
*Journal of Immunology, The *(U. S.)*

***J. Indian Chem. Soc.***
*Journal of the Indian Chemical Society *(India)*

***J. Inorg. Nucl. Chem.***
*Journal of Inorganic & Nuclear Chemistry *(England)*

***J. Inst. Metals***
*Journal of the Institute of Metals with Bulletin and Metallurgical Abstracts *(England)*

***J. Japan Inst. Metals (Sendai)***
Journal of the Japan Institute of Metals (Sendai)
*see Nippon Kinzoku Gakkaishi*

***J. Joint Panel Nucl. Marine Propulsion***
*Journal of the Joint Panel on Nuclear Marine Propulsion *(England)*

***J. Lab. Clin. Med.***
*Journal of Laboratory and Clinical Medicine, The *(U. S.)*

***J. Less-Common Metals***
*Journal of the Less-Common Metals *(Netherlands)*

***J. Math. Anal. Appl.***
*Journal of Mathematical Analysis and Applications *(U. S.)*

***J. Math. Phys. (N. Y.)***
*Journal of Mathematical Physics (New York) *(U. S.)*

***J. Mecan.***
*Journal de Mecanique *(France)*

***J. Metals***
*Journal of Metals *(U. S.)*

***J. Meteorol.***
*Journal of Meteorology, The *(U. S.)*

***J. Mol. Biol.***
*Journal of Molecular Biology *(England)*

***J. Mol. Spectry.***
*Journal of Molecular Spectroscopy *(U. S.)*

***J. Natl. Cancer Inst.***
*Journal of the National Cancer Institute *(U. S.)*

***J. Natl. Res. Council Thailand***
*Journal of the National Research Council of Thailand (contains Part I. Natural Science and Part II. Social Science, paged separately) *(Thailand)*

***J. Nat. Sci. Math.***
*Journal of Natural Sciences and Mathematics *(Pakistan)*

***J. Nucl. Energy: Pt. A & B***
*Journal of Nuclear Energy: Parts A & B. Reactor Science and Technology (formerly issued separately) *(England)*

***J. Nucl. Energy: Pt. C***
*Journal of Nuclear Energy: Part C. Plasma Physics–Accelerators–Thermonuclear Research *(England)*

***J. Nucl. Mater.***
*Journal of Nuclear Materials (Journal des Materiaux Nucleaires) *(Netherlands)*

***J. Nucl. Med.***
*Journal of Nuclear Medicine *(U. S.)*

***J. Opt. Soc. Am.***
*Journal of the Optical Society of America *(U. S.)*

***J. Org. Chem.***
*Journal of Organic Chemistry, The *(U. S.)*

***J. Osaka City Med. Center***
Journal of the Osaka City Medical Center, The
*see Osaka Shiritsu Daigaku Igaku Zasshi*

***J. Phys. (Paris)***
*Journal de Physique (Paris) (formerly Le Journal de Physique et le Radium) *(France)*

***J. Phys. Chem.***
*Journal of Physical Chemistry, The *(U. S.)*

***J. Phys. Chem. Solids***
*Journal of Physics and Chemistry of Solids (formerly Physics and Chemistry of Solids, The) *(U. S.)*

***J. Phys., Phys. Appl. (Paris)***
*Journal de Physique, Physique Applique (Paris). Supplement au Journal de Physique (Paris) *(France)*

***J. Phys. Soc. Japan***
*Journal of the Physical Society of Japan

***J. Polymer Sci. Pt. A***
*Journal of Polymer Science. Part A: General Papers *(U. S.)*

***J. Polymer Sci. Pt. B***
*Journal of Polymer Science. Part B: Polymer Letters *(U. S.)*

***J. Polymer Sci. Pt. C***
*Journal of Polymer Science. Part C: Polymer Symposia *(U. S.)*

***J. Proc. Roy. Soc. N. S. Wales***
*Journal and Proceedings of the Royal Society of New South Wales *(Australia)*

***J. Quant. Spectry. Radiative Transfer***
*Journal of Quantitative Spectroscopy & Radiative Transfer *(England)*

***J. Radiation Res. (Japan)***
*Journal of Radiation Research *(Japan)*

***J. Radiol., Electrol. Med. Nucl.***
*Journal de Radiologie, d'Electrologie, et de Medicine Nucleaire *(France)*

***J. Res. Inst. Catalysis, Hokkaido Univ.***
*Journal of the Research Institute for Catalysis, Hokkaido University *(Japan)*

***J. Res. Natl. Bur. Std.***
*Journal of Research of the National Bureau of Standards (now divided into the following sections: A. Physics and Chemistry; B. Mathematics and Mathematical Physics; C. Engineering and Instrumentation; and D. Radio Science (formerly Radio Propagation)) *(U. S.)*

***J. Sci. Food Agr.***
*Journal of the Science of Food and Agriculture *(England)*

***J. Sci. Hiroshima Univ. Ser. A-II***
*Journal of Science of the Hiroshima University. Series A-II *(Japan)*

***J. Sci. Ind. Res. (India)***
*Journal of Scientific and Industrial Research *(India)*

***J. Sci. Instr.***
*Journal of Scientific Instruments *(England)*

***J. Tenn. Acad. Sci.***
*Journal of the Tennessee Academy of Science *(U. S.)*

***J. Theoret. Biol.***
*Journal of Theoretical Biology *(England)*

***J. Ultrastruct. Res.***
*Journal of Ultrastructure Research *(U. S.)*

***Kernenergie***
*Kernenergie *(Germany)*

***Kerntechnik***
*Kerntechnik, Isotopentechnik und -Chemie *(Germany)*

***Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd.***
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-fysiske Meddelelser *(Denmark)*

***Kgl. Danske Videnskab. Selskab, Mat. Fys. Skrifter***
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-Fysiske Skrifter *(Denmark)*

***Kgl. Norske Videnskab. Selskabs, Forh.***
*Kongelige Norske Videnskabers Selskabs, Det, Forhandlinger *(Norway)*

***Kinetika i Kataliz***
*Kinetika i Kataliz† *(U.S.S.R.)*

***Klin. Wochschr.***
*Klinische Wochenschrift *(Germany)*

***K'o Hsueh T'ung Pao***
*K'o Hsueh T'ung Pao (Scientia) *(China)*

***Kolloidn. Zh.***
*Kolloidnyi Zhurnal† *(U.S.S.R.)*

***Kosmos (Warsaw) Ser. A***
*Kosmos (Warsaw) Seria A: Biologia *(Poland)*

***Kyushu J. Med. Sci.***
*Kyushu Journal of Medical Science *(Japan)*

***Lab. Invest.***
*Laboratory Investigation *(U. S.)*

***Latvijas PSR Zinatnu Akad. Vestis***
*Latvijas PSR Zinatnu Akademijas Vestis *(Latvian S.S.R.)*

***Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos***
*Lietuvos Fizikos Rinkinys, Lietuvos TSR Mokslu Akademija, Lietuvos TSR Aukstosios Mokyklos *(Lithuanian S.S.R.)*

***Lietuvos TSR Mokslu Akad. Darbai: Ser. B***
*Lietuvos TSR Mokslu Akademija Darbai: Serija B *(Lithuanian S.S.R.)*

***Lille Med.***
*Lille Medical *(France)*

***Limnol. Oceanog.***
*Limnology and Oceanography *(U. S.)*

***Litovsk. Mat. Sb.***
*Litovskii Matematicheskikh Sbornik *(Lithuanian S.S.R.)*

***Magy. Fiz. Folyoirat***
*Magyar Fizikai Folyoirat *(Hungary)*

***Magy. Radiol.***
*Magyar Radiologia *(Hungary)*

***Magy. Tud. Akad. At. Kut. Int. (Debrecen). Kozlemen.***
Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek
**see *At. Kozlemen.***

***Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen.***
*Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezetenek Kozlemenyei *(Hungary)*

***Magy. Tud. Akad. Muszaki Tud. Oszt. Kozlemenyei***
*Magyar Tudomanyos Akademia Muszaki Tudomanyok Osztalyanak Kozlemenyei *(Hungary)*

***Makromol. Chem.***
*Makromolekulare Chemie *(Switzerland)*

***Mal. Cardiovascolari***
*Malattie Cardiovascolari *(Italy)*

***Mater. Design Eng.***
*Materials in Design Engineering (formerly Materials & Methods) *(U. S.)*

***Mater. Evaluation***
*Materials Evaluation (formerly Nondestructive Testing) *(U. S.)*

***Mater. Res. Std.***
*Materials Research & Standards (Formerly ASTM (American Society for Testing Materials) Bulletin) *(U. S.)*

***Med. Doswiadczalna Mikrobiol.***
*Medycyna Doswiadczalna i Mikrobiologia *(Poland)*

***Med. Exptl.***
*Medicina Experimentalis *(Switzerland)*

***Medicamundi***
*Medicamundi *(Netherlands)*

***Medicina (Mex.)***
*Medicina *(Mexico)*

***Med. J. Malaya***
*Medical Journal of Malaya, The *(Malaya)*

***Med. Radiol.***
*Meditsinskaya Radiologiya† *(U.S.S.R.)*

***Mem. Acad. Roy. Med. Belg.***
*Memoires de l'Academie Royale de Medecine de Belgique *(Belgium)*

***Mem. Fac. Sci., Kyushu Univ. Ser. B***
*Memoirs of the Faculty of Science, Kyushu University. Series B *(Japan)*

***Mem. Sci. Rev. Met.***
*Memoires Scientifiques de la Revue de Metallurgie, Les (formerly a part of Revue de Metallurgie) *(France)*

***Mem. Soc. Vaudoise Sci. Nat.***
*Memoires de la Societe Vaudoise des Sciences Naturelles *(Switzerland)*

***Metall***
*Metall *(Germany)*

***Metalloved. i Term. Obrabotka Metal.***
*Metallovedenie i Termicheskaya Obrabotka Metallov† (formerly Metallovedenie i Obrabotka Metallov) *(U.S.S.R.)*

***Metallurgia***
*Metallurgia *(England)*

***Metal Progr.***
*Metal Progress *(U. S.)*

***Metals Eng. Quart.***
*Metals Engineering Quarterly *(U. S.)*

***Met. Ital.***
*Metallurgia Italiana, La *(Italy)*

***Met. Rev.***
*Metallurgical Reviews *(England)*

***Microchem. J.***
*Microchemical Journal *(U. S.)*

***Mikrochim. Ichnoanal. Acta***
*Mikrochimica et Ichnoanalytica Acta (formerly Mikrochimica Acta) *(Austria)*

***Minerva Nucl.***
*Minerva Nucleare *(Italy)*

***Mitteilungsbl. Strahlungsmessgeraete***
*Mitteilungsblaetter Strahlungsmessgeraete *(Germany)*

***Mol. Phys.***
*Molecular Physics *(U. S.)*

***Monatsber. Deut. Akad. Wiss. Berlin***
*Monatsberichte der Deutschen Akademie der Wissenschaften su Berlin *(Germany)*

***Monthly Notices Roy. Astron. Soc.***
*Monthly Notices of the Royal Astronomical Society *(England)*

***Montpellier Med.***
*Montpellier Medical *(France)*

***Natl. Defense Med. J. (Japan)***
National Defense Medical Journal (Japan)
**see *Boei Eisei***

***Natl. Inst. Animal Health Quart.***
*National Institute of Animal Health Quarterly (Tokyo) *(Japan)*

***Nature***
*Nature (London) *(England)*

***Naturwissenschaften***
*Naturwissenschaften, Die *(Germany)*

***Ned. Tijdschr. Natuurk.***
*Nederlands Tijdschrift voor Natuurkunde *(Netherlands)*
***Neoplasma***
*Neoplasma *(Czechoslovakia)*
***Neue Physik***
*Neue Physik *(Austria)*
***Neue Tech.***
*Neue Technik *(Germany)*
***Neurocirugia (Lima)***
*Neurocirugia (Lima) *(Peru)*
***New Scientist***
*New Scientist, The *(England)*
***New Zealand J. Sci.***
*New Zealand Journal of Science *(New Zealand)*
***Nippon Genshiryoku Gakkaishi***
*Nippon Genshiryoku Gakkaishi (Journal of the Atomic Energy Society of Japan) *(Japan)*
***Nippon Kagaku Zasshi***
*Nippon Kagaku Zasshi (Journal of the Chemistry Society of Japan, Pure Chemistry Section) *(Japan)*
***Nippon Kinzoku Gakkaishi***
*Nippon Kinzoku Gakkaishi (Journal of the Japan Institute of Metals (Sendai)) *(Japan)*
***Nucl. Energy***
*Nuclear Energy (formerly Nuclear Energy Engineer) *(England)*
***Nucl. Eng.***
*Nuclear Engineering incorporating Nuclear Power *(England)*
***Nuclear Eng. (Tokyo)***
Nuclear Engineering (Tokyo)
**see *Genshiryoku Kogyo***
***Nucleonics***
*Nucleonics *(U. S.)*
***Nucleus (Paris)***
*Nucleus. La Revue Scientifique a l'Age Atomique (Paris) *(France)*
***Nucl. Fusion***
*Nuclear Fusion (Journal of Plasma Physics and Thermonuclear Fusion *(Austria)*
***Nucl. Inform.***
*Nuclear Information *(U. S.)*
***Nucl. Instr. Methods***
*Nuclear Instruments & Methods (formerly Nuclear Instruments) *(Netherlands)*
***Nucl.-Med.***
*Nuclear-Medizin *(Germany)*
***Nucl. News***
*Nuclear News *(U. S.)*
***Nucl. Phys.***
*Nuclear Physics *(Netherlands)*
***Nucl. Sci. (Taiwan)***
Nuclear Science (Taiwan) *(China)*
**see *Ho Tsu K'o Hsueh***
***Nucl. Sci. Abstr. Japan***
*Nuclear Science Abstracts of Japan *(Japan)*
***Nucl. Sci. Eng.***
*Nuclear Science and Engineering *(U. S.)*
***Nukleonik***
*Nukleonik *(Germany)*
***Nukleonika***
*Nukleonika *(Poland)*
***Nuntius Radiol.***
*Nuntius Radiologicus *(Italy)*
***Nuovo Cimento***
*Nuovo Cimento (Including all supplements) *(Italy)*
***Ogneupory***
*Ogneupory† *(U.S.S.R.)*
***Oncologia***
*Oncologia *(Switzerland)*
***Onde Elec.***
*Onde Electrique, L' *(France)*
***Ophthalmol. Ibero-Am.***
*Ophthalmologia Ibero-Americana *(Brazil)*

***Opt. Spectry. (USSR) (English Transl.)***
*Optics and Spectroscopy (USSR) (English Translation of Optika i Spektroskopiya) *(U. S.)*
***Osaka City Med. J.***
*Osaka City Medical Journal *(Japan)*
***Osaka Shiritsu Daigaku Igaku Zasshi***
*Osaka Shiritsu Daigaku Igaku Zasshi (The Journal of the Osaka City Medical Center) *(Japan)*
***Pakistan J. Sci. Ind. Res.***
*Pakistan Journal of Scientific and Industrial Research *(Pakistan)*
***Pathol. Biol. Semaine Hop.***
*Pathologie et Biologie, Archives de Biologie Medicale, Annales de la Recherche Medicale, La Semaine des Hopitaux *(France)*
***Pathologica***
*Pathologica *(Italy)*
***Pediat. Pratica***
*Pediatria Pratica *(Brazil)*
***Pediatria (Santiago, Chile)***
*Pediatria (Santiago, Chile) *(Chile)*
***Perspectives Biol. Med.***
*Perspectives in Biology and Medicine *(U. S.)*
***Philippine J. Sci.***
*Philippine Journal of Science *(Philippines)*
***Philips Res. Rept.***
*Philips Research Reports *(Netherlands)*
***Philips Tech. Rev.***
*Philips Technical Review *(Netherlands)*
***Phil. Mag.***
*Philosophical Magazine, The *(England)*
***Phot. Sci. Eng.***
*Photographic Science and Engineering *(U. S.)*
***Phys. Fluids***
*Physics of Fluids, The *(U. S.)*
***Physica***
*Physica *(Netherlands)*
***Phys. Letters***
*Physics Letters *(Netherlands)*
***Phys. Med. Biol.***
*Physics in Medicine and Biology *(England)*
***Phys. Norvegica***
*Physica Norvegica *(Norway)*
***Phys. Rev.***
*Physical Review, The *(U. S.)*
***Phys. Rev. Letters***
*Physical Review Letters *(U. S.)*
***Phys. Status Solidi***
*Physica Status Solidi *(Germany)*
***Planetary Space Sci.***
*Planetary and Space Science *(England)*
***Planseeber. Pulvermet.***
*Planseeberichte fuer Pulvermetallurgie Vereinigt mit Powder Metallurgy Bulletin *(Austria)*
***Plant Physiol.***
*Plant Physiology *(U. S.)*
***Plasma Phys.-Accelerators-Thermonucl. Res., J. Nucl. Energy: Pt. C***
Plasma Physics-Accelerators-Thermonuclear Research, Journal of Nuclear Energy: Part C
**see *J. Nucl. Energy: Pt. C***
***Polskie Arch. Med. Wewnetrznej***
*Polskie Archiwum Medycyny Wewnetrznej *(Poland)*
***Polski Przeglad Radiol. i Med. Nuklearnej***
*Polski Przeglad Radiologii i Medycyny Nuklearnej *(Poland)*
***Polymer***
*Polymer *(England)*
***Poroshkovaya Met., Akad. Nauk Ukr. SSR***
*Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR *(Ukrainian S.S.R.)*
***Postepy Fiz.***
*Postepy Fizyki *(Poland)*

***Powder Met.***
*Powder Metallurgy *(England)*
***Prace Inst. Hutniczych***
*Prace Instytutow Hutniczych *(Poland)*
***Pracovni Lekar.***
*Pracovni Lekarstvi *(Czechoslovakia)*
***Presbyterian-St. Luke's Hosp. Med. Bull.***
*Presbyterian-St. Luke's Hospital Medical Bulletin *(U. S.)*
***Pribory i Tekhn. Eksperim.***
*Pribory i Tekhnika Eksperimenta† *(U.S.S.R.)*
***Prikl. Mat. i Mekhan.***
*Prikladnaya Matematika i Mekhanika† *(U.S.S.R.)*
***Primena Radioaktiv. Izotopa i Jonizujucih Zracenja u Med.***
*Primena Radioaktivnih Izotopa i Jonizujucih Zracenja u Medicini *(Yugoslavia)*
***Priroda***
*Priroda *(U.S.S.R.)*
***Proc. Cambridge Phil. Soc.***
*Proceedings of the Cambridge Philosophical Society (England)
***Proc. Chem. Soc.***
*Proceedings of the Chemical Society *(England)*
***Proc. IEEE (Inst. Elec. Electron. Engrs.)***
*Proceedings of the IEEE (Institute of Electrical and Electronics Engineers) (formerly Proceedings of the Institute of Radio Engineers) *(U. S.)*
***Proc. Indian Acad. Sci., Sect. A***
*Proceedings of the Indian Academy of Sciences, Section A *(India)*
***Proc. Inst. Elec. Engrs. (London), Pt. B***
*Proceedings of the Institution of Electrical Engineers, The (London) (formerly Journal of the Institution of Electrical Engineers), Pt. B *(England)*
***Proc. Inst. Nucl. Med. Biol. (Japan)***
*Proceedings of the Institute for Nuclear Medicine and Biology (formerly Proceedings of the Institute for Nuclear Radiation Research) *(Japan)*
***Proc. Iowa Acad. Sci.***
*Proceedings of the Iowa Academy of Science *(U. S.)*
***Proc. Math. Phys. Soc. (U.A.R.)***
*Proceedings of the Mathematical and Physical Society of (U. A. R.) *(Egypt)*
***Proc. Natl. Acad. Sci. U. S.***
*Proceedings of the National Academy of Sciences of the United States of America *(U. S.)*
***Proc. Natl. Inst. Sci. India. Pt. A***
*Proceedings of the National Institute of Sciences of India. Part A *(India)*
***Proc. Natl. Inst. Sci. India, Pt. B***
*Proceedings of the National Institute of Sciences of India, Part B *(India)*
***Proc. Phys. Seminar Trondheim***
Proceedings of the Physics Seminar in Trondheim
***see Ark. Fys. Seminar Trondheim***
***Proc. Phys. Soc. (London)***
*Proceedings of the Physical Society (London), The *(England)*
***Proc. Roy. Irish Acad., Sect. A***
*Proceedings of the Royal Irish Academy, Section A *(Ireland)*
***Proc. Roy. Soc. (London), Ser. A***
*Proceedings of the Royal Society (London), Series A *(England)*
***Proc. Roy. Soc. (London), Ser. B***
*Proceedings of the Royal Society (London), Series B *(England)*
***Proc. Soc. Exptl. Biol. Med.***
*Proceedings of the Society for Experimental Biology and Medicine *(U. S.)*
***Progr. Nucl. Phys.***
*Progress in Nuclear Physics *(U. S.)*
***Progr. Theoret. Phys. (Kyoto)***
*Progress of Theoretical Physics (Kyoto) *(Japan)*
***Progr. Theoret. Phys. (Kyoto), Suppl.***
*Progress of Theoretical Physics (Kyoto), Supplement *(Japan)*

***Protides Biol. Fluids, Proc. Colloq.***
*Protides of the Biological Fluids, Proceedings of the Colloquium *(Belgium)*
***Przeglad Elektron.***
*Przeglad Elektroniki *(Poland)*
***Przeglad Geol.***
*Przeglad Geologiczny *(Poland)*
***Przeglad Lekar.***
*Przeglad Lekarski *(Poland)*
***Przeglad Odlewnictwa***
*Przeglad Odlewnictwa *(Poland)*
***Przeglad Spawalnictwa***
*Przeglad Spawalnictwa *(Poland)*
***Przeglad Telekomun.***
*Przeglad Telekomunikacyjny *(Poland)*
***Przemysl Chem.***
*Przemysl Chemiczny *(Poland)*
***Public Health Eng. Abstr.***
*Public Health Engineering Abstracts *(U. S.)*
***Public Health Rept. (U. S.)***
*Public Health Reports *(U. S.)*
***Pure Appl. Chem.***
*Pure and Applied Chemistry (The Official Journal of the International Union of Pure and Applied Chemistry) *(U. S.)*
***Quart. Appl. Math.***
*Quarterly of Applied Mathematics *(U. S.)*
***Quart. J. Roy. Astron. Soc.***
*Quarterly Journal of the Royal Astronomical Society, The *(England)*
***Quart. Rev. (London)***
*Quarterly Reviews (London) *(England)*
***Quart. Rev. Biol.***
*Quarterly Review of Biology, The *(U. S.)*
***Radiation Botany***
*Radiation Botany *(England)*
***Radiation Res.***
*Radiation Research *(U. S.)*
***Radiation Res. Polymers***
Radiation Research on Polymers
***see Hoshasen Kobunshi***
***Radiobiol. Latina***
*Radiobiologica Latina *(Italy)*
***Radiobiologiya***
*Radiobiologiya† *(U.S.S.R.)*
***Radiobiol. Radioterap. Fis. Med.***
*Radiobiologia, Radioterapia e Fisica Medica (formerly Radioterapia, Radiobiologia e Fisica Medica) *(Italy)*
***Radiobiol. Radiotherap.***
*Radiobiologia–Radiotherapie *(Germany)*
***Radiocarbon***
*Radiocarbon *(U. S.)*
***Radiochim. Acta***
*Radiochimica Acta *(Germany)*
***Radioisotopes (Tokyo)***
*Radioisotopes (Tokyo) *(Japan)*
***Radiokhimiya***
*Radiokhimiya† *(U.S.S.R.)*
***Radiol. Clin.***
*Radiologia Clinica *(Switzerland)*
***Radiol. Diagn.***
*Radiologia Diagnostica *(Germany)*
***Radiol. Med.***
*Radiologia Medica, La *(Italy)*
***Radiology***
*Radiology *(U. S.)*
***Radiotekhn. i Elektron.***
*Radiotekhnika i Elektronika† *(U.S.S.R.)*
***R C A Rev.***
*R C A Review *(U. S.)*
***Reactor Sci. Technol., J. Nucl. Energy: Pt. A & B***
Reactor Science and Technology, Journal of Nuclear Energy: Parts A & B

***see J. Nucl. Energy: Pt. A & B***

***Rec. Trav. Chim.***
*Recueil des Travaux Chimiques des Pays-Bas *(Netherlands)*

***Rept. Govt. Chem. Ind. Res. Inst., Tokyo***
Reports of the Government Chemical Industrial Research Institute, Tokyo
***see Tokyo Kogyo Shikensho Hokoku***

***Rept. Inst. Phys. Chem. Res. (Tokyo)***
Reports of the Institute of Physical and Chemical Research (Tokyo)
***see Rika Gaku Kenkyusho Hokoku***

***Res. Reactor J.***
*Research Reactor Journal *(U. S.)*

***Reumatismo***
*Reumatismo *(Italy)*

***Rev. Arg. Alergia***
*Revista Argentina de Alergia *(Argentina)*

***Rev. Arg. Anestesiol.***
*Revista Argentina de Anestesiologia *(Argentina)*

***Rev. Arg. Tuberc. Enfermedades Pulmonares***
*Revista Argentina de Tuberculosis y Enfermedades Pulmonares *(Argentina)*

***Rev. Asoc. Med. Rio Grande do Sul***
*Revista da Asociacao Medica do Rio Grande do Sul *(Brazil)*

***Rev. Belge Pathol. Med. Exptl.***
*Revue Belge de Pathologie et de Medecine Experimentale *(Belgium)*

***Rev. Brasil. Gastroenterol.***
*Revista Brasileira de Gastroenterologia *(Brazil)*

***Rev. Can. Biol.***
*Revue Canadienne de Biologie *(Canada)*

***Rev. Chilena Pediat.***
*Revista Chilena de Pediatria *(Chile)*

***Rev. Col. Med. Guatemala***
*Revista del Colegio Medico de Guatemala *(Guatemala)*

***Rev. Cubana Cardiol.***
*Revista Cubana de Cardiologia *(Cuba)*

***Rev. Electrotech. Energet., Acad. Rep. Populaire Roumaine***
*Revue d'Electrotechnique et d'Energetique, Academie de la Republique Populaire Roumaine *(Romania)*

***Rev. Espan. Fisiol.***
*Revista Espanola de Fisiologia *(Spain)*

***Rev. Espan. Oto-neuro-oftalmol. Neurocir.***
*Revista Espanola de Oto-neuro-oftalmologia y Neurocirugia *(Spain)*

***Rev. Espan. Reumat. Enfermedades Osteoarticulares***
*Revista Espanola de Reumatismo y Enfermedades Osteo-articulares *(Spain)*

***Rev. Espan. Tuberc.***
*Revista Espanola de Tuberculosis y Archivos Nacionales de Enfermedades del Torax *(Spain)*

***Rev. Geophys.***
*Reviews of Geophysics *(U. S.)*

***Rev. Ginecol. Obstet. (Rio de Janeiro)***
*Revista de Ginecologia e d'Obstetricia (Rio de Janeiro) *(Brazil)*

***Rev. Goiana Med.***
*Revista Goiana de Medicina *(Brazil)*

***Rev. Hosp. Clin., Fac. Med., Univ. Sao Paulo***
*Revista do Hospital das Clinicas, Faculdade de Medicina, Universidade de Sao Paulo *(Brazil)*

***Rev. Hosp. Nino (Lima)***
*Revista del Hospital del Nino (Lima) *(Peru)*

***Rev. Hosp. San Juan de Dios (Bogota)***
*Revista del Hospital de San Juan de Dios (Bogota) *(Colombia)*

***Rev. Iberica Endocrinol.***
*Revista Iberica de Endocrinologia *(Spain)*

***Rev. Immunol.***
*Revue d'Immunologie et de Therapie Antimicrobienne *(France)*

***Rev. Inst. Franc. Petrole Ann. Combust. Liquides***
*Revue de l'Institut Francais du Petrole et Annales des Combustibles Liquides *(France)*

***Rev. Inst. Med. Trop. Sao Paulo***
*Revista do Instituto de Medicina Tropical de Sao Paulo *(Brazil)*

***Rev. Invest. Clin. Organo Hosp. Enfermedades Nutr. Mex.***
*Revista de Investigacion Clinica, Organo del Hospital de Enfermedades de la Nutricion, Mexico *(Mexico)*

***Rev. Latinoam. Anat. Patol.***
*Revista Latinoamericana de Anatomia Patologica *(Venezuela)*

***Rev. Latino-Am. Cir. Plastica***
*Revista Latinoamericana de Cirugia Plastica *(Mexico)*

***Rev. Latinoam. Microbiol.***
*Revista Latinoamericana de Microbiologia *(Mexico)*

***Rev. Leprol. (Fontilles)***
*Revista de Leprologia (Fontilles) *(Spain)*

***Rev. M.B.L.E.***
*Revue de Manufacture Belge de Lampes et de Materiel *(Belgium)*

***Rev. Med. Aeronaut. (Rio de Janeiro)***
*Revista Medica da Aeronautica (Rio de Janeiro) *(Brazil)*

***Rev. Med. Cordoba***
*Revista Medica de Cordoba *(Argentina)*

***Rev. Med. Hosp. Colonia (Mex.)***
*Revista Medica del Hospital Colonia *(Mexico)*

***Rev. Med. Hosp. Espan. (Mex.)***
*Revista Medica del Hospital Espanol *(Mexico)*

***Rev. Med. Hosp. Obrero (Lima)***
*Revista Medica del Hospital Obrero (Lima) *(Peru)*

***Rev. Med. Rio Grande do Sul***
*Revista de Medicina do Rio Grande do Sul *(Brazil)*

***Rev. Med. Valparaiso***
*Revista Medica de Valparaiso *(Chile)*

***Rev. Met. (Paris)***
*Revue de Metallurgie (Paris) *(France)*

***Rev. Metal Lit.***
*Review of Metal Literature *(U. S.)*

***Rev. Mex. Cienc. Med. Biol.***
*Revista Mexicana de Ciencias Medicas y Biologicas *(Mexico)*

***Rev. Mex. Cir. Ginecol. Cancer***
*Revista Mexicana de Cirugia, Ginecologia y Cancer *(Mexico)*

***Rev. Mex. Fis.***
*Revista Mexicana de Fisica *(Mexico)*

***Rev. Mex. Tuberc. Aparato Respirat.***
*Revista Mexicana de Tuberculosis y Aparato Respiratorio *(Mexico)*

***Rev. Mod. Phys.***
*Reviews of Modern Physics *(U. S.)*

***Rev. Neurol. Buenos Aires***
*Revista Neurologica de Buenos Aires *(Argentina)*

***Rev. Obstet. Ginecol. (Caracas)***
*Revista de Obstetricia y Ginecologia (Caracas) *(Venezuela)*

***Rev. Ortoped. Traumatol. Latinoam.***
*Revista de Ortopedia y Traumatologia Latinoamericana *(Argentina)*

***Rev. Otorrinolaringol. (Santiago, Chile)***
*Revista de Otorrinolaringologia (Santiago, Chile) *(Chile)*

***Rev. Phys., Acad. Rep. Populaire Roumaine***
*Revue de Physique, Academie de la Republique Populaire Roumaine *(Romania)*

***Rev. Psiquiat. (Santiago, Chile)***
*Revista de Psiquiatria (Santiago, Chile) *(Chile)*

***Rev. Psiquiat. Peruana***
*Revista Psiquiatrica Peruana *(Peru)*

***Rev. Pure Appl. Chem.***
*Reviews of Pure and Applied Chemistry *(Australia)*

***Rev. Rhumat.***
*Revue du Rhumatisme et des Maladies Osteo-Articulaires *(France)*

***Rev. Sci. Instr.***
*Review of Scientific Instruments, The *(U. S.)*
***Rev. Soc. Med.-Quir. Zulia***
*Revista de la Sociedad Medico-Quirurgica del Zulia *(Venezuela)*
***Rev. Soc. Quim. Mex.***
*Revista de la Sociedad Quimica de Mexico *(Mexico)*
***Rev. Union Mat. Arg. Asoc. Fis. Arg.***
*Revista de la Union Matematica Argentina y de la Asociacion Fisica Argentina *(Argentina)*
***Rev. Univ. Ind. Santander***
*Revista de la Universidad Industrial de Santander *(Colombia)*
***Rev. Urol. (Caracas)***
*Revista de Urologia (Caracas) *(Venezuela)*
***Rev. Urol. (Mex.)***
*Revista de Urologia *(Mexico)*
***Rheumatism***
*Rheumatism *(England)*
***Ric. Sci. Rend., Sez. A***
*Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione A, Abiologica *(Italy)*
***Ric. Sci. Rend., Sez. B***
*Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione B, Biologica *(Italy)*
***Rika Gaku Kenkyusho Hokoku***
*Rika Gaku Kenkyusho Hokoku (Reports of the Institute of Physical and Chemical Research) *(Japan)*
***Riv. Biol.***
*Rivista di Biologia (Pubblicata a Cura dell'Istituto di Biologia Generale dell'Universita di Perugia) *(Italy)*
***Riv. Clin. Pediat.***
*Rivista di Clinica Pediatrica *(Italy)*
***Riv. Ing. Nucl.***
*Rivista di Ingegneria Nucleare *(Italy)*
***Riv. Ist. Sieroterap. Ital.***
*Rivista dell'Istituto Sieroterapico Italiano *(Italy)*
***Roczniki Chem.***
*Roczniki Chemii *(Poland)*
***Roczniki Panstwowego Zakladu Hig.***
*Roczniki Panstwowego Zakladu Higieny *(Poland)*
***Rudy Metale Niezelazne***
*Rudy i Metale Niezelazne *(Poland)*
***Rumanian Med. Rev.***
*Rumanian Medical Review *(Romania)*
***Santo Tomas J. Med.***
*Santo Tomas Journal of Medicine *(Philippines)*
***Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR***
*Sbornik Nauchnykh Trudov Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR (formerly Sbornik Nauchnykh Rabot Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR) *(Ukrainian S.S.R.)*
***Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove***
*Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove *(Czechoslovakia)*
***Schweiz. Arch. Angew. Wiss. Tech.***
*Schweizer Archiv fuer Angewandte Wissenschaft und Technik *(Switzerland)*
***Sci. Am.***
*Scientific American *(U. S.)*
***Science***
*Science *(U. S.)*
***Scientia***
Scientia
**see *K'o Hsueh T'ung Pao***
***Scientia (Valparaiso, Chile)***
*Scientia (Valparaiso, Chile) *(Chile)*
***Sci. Papers Coll. Gen. Educ., Univ. Tokyo***
*Scientific Papers of the College of General Education, University of Tokyo *(Japan)*
***Sci. Papers Inst. Phys. Chem. Res. (Tokyo)***
*Scientific Papers of the Institute of Physical and Chemical Research (Tokyo) (formerly Journal of the Scientific Research Institute (Tokyo)) *(Japan)*
***Sci. Progr. (London)***
*Science Progress (London) *(England)*
***Sci. Progr.-Nature***
*Science Progres–La Nature *(France)*
***Sci. Rept. Res. Inst. Theoret. Phys., Hiroshima Univ.***
*Scientific Reports of the Research Institute for Theoretical Physics, Hiroshima University *(Japan)*
***Sci. Rept. Res. Inst., Tohoku Univ., Ser. A***
*Scientific Reports of the Research Institutes, The, Tohoku University, Series A *(Japan)*
***Sci. Sinica (Peking)***
*Scientia Sinica (Peking) *(China)*
***SIAM (Soc. Ind. Appl. Math.) Rev.***
*SIAM (Society for Industrial and Applied Mathematics) Review *(U. S.)*
***Soc. Sci. Fennica, Commentationes Phys.-Math.***
*Societas Scientiarum Fennica, Commentationes Physico-Mathematicae *(Finland)*
***Soil Sci.***
*Soil Science *(U. S.)*
***Soil Sci. Soc. Am., Proc.***
*Soil Science Society of America, Proceedings *(U. S.)*
***Solid State Commun.***
*Solid State Communications *(U. S.)*
***Soviet Astron. AJ (English Transl.)***
*Soviet Astronomy–AJ (English Translation of Astronomicheskii Zhurnal) *(U. S.)*
***Soviet Phys.–Cryst. (English Transl.)***
*Soviet Physics–Crystallography (English Translation of Kristallografiya) *(U. S.)*
***Soviet Phys.-Solid State (English Transl.)***
*Soviet Physics–Solid State (English translation of Fizika Tverdogo Tela) *(U. S.)*
***Space Sci. Rev.***
*Space Science Reviews *(Netherlands)*
***Spectrochim. Acta***
*Spectrochimica Acta *(England)*
***Staub***
*Staub *(Germany)*
***Strahlentherapie***
*Strahlentherapie *(Germany)*
***Studia Univ. Babes-Bolyai, Ser. Chem.***
*Studia Universitatis Babes-Bolyai, Series Chemia *(Romania)*
***Studia Univ. Babes-Bolyai, Ser. Math.-Phys.***
*Studia Universitatis Babes-Bolyai, Series Mathematica-Physica *(Romania)*
***Sulzer Tech. Rev. (Switz.)***
*Sulzer Technical Review *(Switzerland)*
***Suomen Kemistilehti, A***
*Suomen Kemistilehti, Section A *(Finland)*
***Suomen Kemistilehti, B***
*Suomen Kemistilehti, Section B *(Finland)*
***Svensk Kem. Tidskr.***
*Svensk Kemisk Tidskrift *(Sweden)*
***Taiki Hoshano Kansoku Seiseki***
*Taiki Hoshano Kansoku Seiseki (Bulletin of the Atmospheric Radioactivity) *(Japan)*
***Talanta***
*Talanta *(England)*
***Tech. Book Rev. Index***
*Technical Book Review Index *(U. S.)*
***Tech. Mitt. Krupp. Forschungsber.***
*Technische Mitteilungen Krupp. Forschungsberichte *(Germany)*
***Tech. Mitt. Krupp. Werksber.***
*Technische Mitteilungen Krupp. Werksberichte *(Germany)*

**Tech. Rept. Eng. Res. Inst., Kyoto Univ.**
*Technical Reports of the Engineering Research Institute, Kyoto University *(Japan)*

**Tech. Ueberwach.**
*Technische Ueberwachung *(Germany)*

**Telefunken Ztg.**
*Telefunken Zeitung *(Germany)*

**Teleteknik (English Ed.)**
*Teleteknik (English Edition) *(Denmark)*

**Tellus**
*Tellus. A Quarterly Journal of Geophysics *(Sweden)*

**Teploenergetika**
*Teploenergetika *(U.S.S.R.)*

**Tetrahedron**
*Tetrahedron *(Northern Ireland)*

**Texas Rept. Biol. Med.**
*Texas Reports on Biology and Medicine *(U. S.)*

**Tidsskr. Kjemi, Bergvesen Met.**
*Tidsskrift for Kjemi, Bergvesen og Metallurgi *(Norway)*

**Tohoku J. Exptl. Med.**
*Tohoku Journal of Experimental Medicine, The *(Japan)*

**Tokushima J. Exptl. Med.**
*Tokushima Journal of Experimental Medicine, The *(Japan)*

**Tokyo Kogyo Shikensho Hokoku**
*Tokyo Kogyo Shikensho Hokoku (Reports of the Government Chemical Industrial Research Institute, Tokyo) *(Japan)*

**Torax**
*Torax *(Uruguay)*

**Toshiba Rev., Intern. Ed.**
*Toshiba Review, International Edition *(Japan)*

**Trans. AIME**
*Transactions of AIME (American Institute of Mining, Metallurgical, and Petroleum Engineers) *(U. S.)*

**Trans. Am. Geophys. Union**
*Transactions of the American Geophysical Union *(U. S.)*

**Trans. Am. Nucl. Soc.**
*Transactions of the American Nuclear Society *(U. S.)*

**Trans. ASME (Am. Soc. Mech. Engrs.), Ser. A: J. Eng. Power**
Transactions of the ASME (American Society of Mechanical Engineers), Series A: Journal of Engineering for Power
**see J. Eng. Power**

**Trans. ASME (Am. Soc. Mech. Engrs.), Ser. B: J. Eng. Ind.**
Transactions of the ASME (American Society of Mechanical Engineers), Series B: Journal of Engineering for Industry
**see J. Eng. Ind.**

**Trans. ASME (Am. Soc. Mech. Engrs.), Ser. C: J. Heat Transfer**
Transactions of the ASME (American Society of Mechanical Engineers), Series C: Journal ofHeat Transfer
**see J. Heat Transfer**

**Trans. ASME (Am. Soc. Mech. Engrs.), Ser. D: J. Basic Eng.**
Transactions of the ASME (American Society of Mechanical Engineers), Series D: Journal of Basic Engineering
**see J. Basic Eng.**

**Trans. ASME (Am. Soc. Mech. Engrs.), Ser. E: J. Appl. Mech.**
Transactions of the ASME (American Society of Mechanical Engineers), Series E: Journal of Applied Mechanics
**see J. Appl. Mech.**

**Trans. Bose Res. Inst. (Calcutta)**
*Transactions of the Bose Research Institute (Calcutta) *(India)*

**Trans. Brit. Ceram. Soc.**
*Transactions of the British Ceramic Society incorporating British Ceramic Abstracts *(England)*

**Trans. Faraday Soc.**
*Transactions of the Faraday Society *(England)*

**Trans. Japan Inst. Metals**
*Transactions of the Japan Institute of Metals (Sendai) *(Japan)*

**Trans. Met. Soc. AIME**
Transactions of the Metallurgical Society of AIME
**see Trans. AIME**

**Trans. Natl. Res. Inst. Metals (Tokyo)**
*Transactions of National Research Institute for Metals (Tokyo) *(Japan)*

**Trans. N. Y. Acad. Sci.**
*Transactions of the New York Academy of Sciences *(U. S.)*

**Transplantation**
*Transplantation (formerly Transplantation Bulletin) *(U. S.)*

**Trend Eng. Univ. Wash.**
*Trend in Engineering at the University of Washington *(U. S.)*

**Tr. Energ. Inst., Akad. Nauk Azerb. SSR**
*Trudy Energeticheskogo Instituta imeni I. G. Es'mana, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

**Tr. Inst. Fiz., Akad. Nauk Azerb. SSR**
*Trudy Instituta Fiziki, Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

**Tr. Inst. Fiz. Akad. Nauk Gruz. SSR**
*Trudy Instituta Fiziki, Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

**Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR**
*Trudy Instituta Fiziki i Astronomii, Akademiya Nauk Estonskoi SSR *(Estonian S.S.R.)*

**Tr. Inst. Geol. Nauk, Akad. Nauk Kaz. SSR**
*Trudy Instituta Geologicheskikh Nauk, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

**Tr. Inst. Yadern. Fiz., Akad. Nauk Kaz. SSR**
*Trudy Instituta Yadernoi Fiziki, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

**Tsvetn. Metal.**
*Tsvetnye Metally† *(U.S.S.R.)*

**Tumori**
*Tumori *(Italy)*

**TVF (Tek. Vetenskaplig Forskning)**
*TVF (Teknisk-Vetenskaplig Forskning) *(Sweden)*

**Uch. Zap. Leningr. Gos. Univ., Ser. Biol. Nauk**
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